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Nr. 5. JUL. GRØNTVED: INVESTIGATIONS ON THE PHYTOPLANKTON IN THE  
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INVESTIGATIONS ON THE  
PHYTOPLANKTON IN THE SOUTHERN  
NORTH SEA IN MAY 1947

BY

JUL. GRØNTVED

WITH 24 TEXT-FIGURES AND 1 PLATE

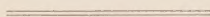
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BIANCO LUNOS BOGTRYKKERI

1952

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## 1. Introduction.

The plankton material on which this treatise is based was gathered in the southern part of the North Sea in May, 1947. At the initiative of THE INTERNATIONAL COUNCIL FOR THE EXPLORATION OF THE SEA, hydrographic collections and observations were made at that time throughout the North Sea, the Skager Rack, the Norwegian Sea and the adjacent westerly waters. In these investigations Denmark was represented by the research ship "DANA" under the charge of Dr. Å. VEDEL TÅNING, and the material here dealt with was collected by that ship which besides undertook other investigations of biological nature concurrently with the hydrographic investigations.

In a previous publication TÅNING (1951) has described the natural oil patch observed during the plankton collection in 1947, and the discovery of two new species, *Chaetoceros sessilis* and the Suctorina *Trichophrya Danae* in the material collected was mentioned by GRØNTVED (1951 a and 1951 b). The quantitative investigation of the material will be given in the following. It has been impossible to include all the frequency tables but a selection is appended to the treatise while the remainder are on file at the PLANKTON LABORATORY, CHARLOTTENLUND SLOT, where they will be available to any one interested in seeing them.

The abovementioned hydrographic investigation was continued in 1948 and 1949 and in May, 1948 a collection of plankton was made throughout the area covered by the investigation, thus also from our investigation area in May 1947. This very considerable plankton material, which will be published by BRAARUD, GAARDER and GRØNTVED (1952) makes it possible to undertake a comparison between the plankton vegetation in May in our area in 1947 and 1948, a comparison which is the more interesting as the temperature in the spring of 1947 was very low, while in 1948 it was about average.

For the microscopic examination of the plankton samples I have received economic support from the RASK-ØRSTED FOUNDATION which also together with FONDET FOR DANSK-NORSK SAMARBEJDE has defrayed my travelling expenses in connection with this work. I extend to these two foundations my respectful thanks for the aid rendered to me.

Dr. J. EGGVIN and J. SMED, M.Sc. have given me the use of the hydrographic data reproduced in figs. 4—7, and I bring them my best thanks for this courtesy.

## 2. Material and Methods.

The area investigated comprises the southern part of the North Sea between lats. 54° and 57° N., but due to the risk of mines at that time prevailing in the waters close the coast of Jutland it was impossible to collect material in the actual coastal waters of the eastern part of the area (Fig. 1).

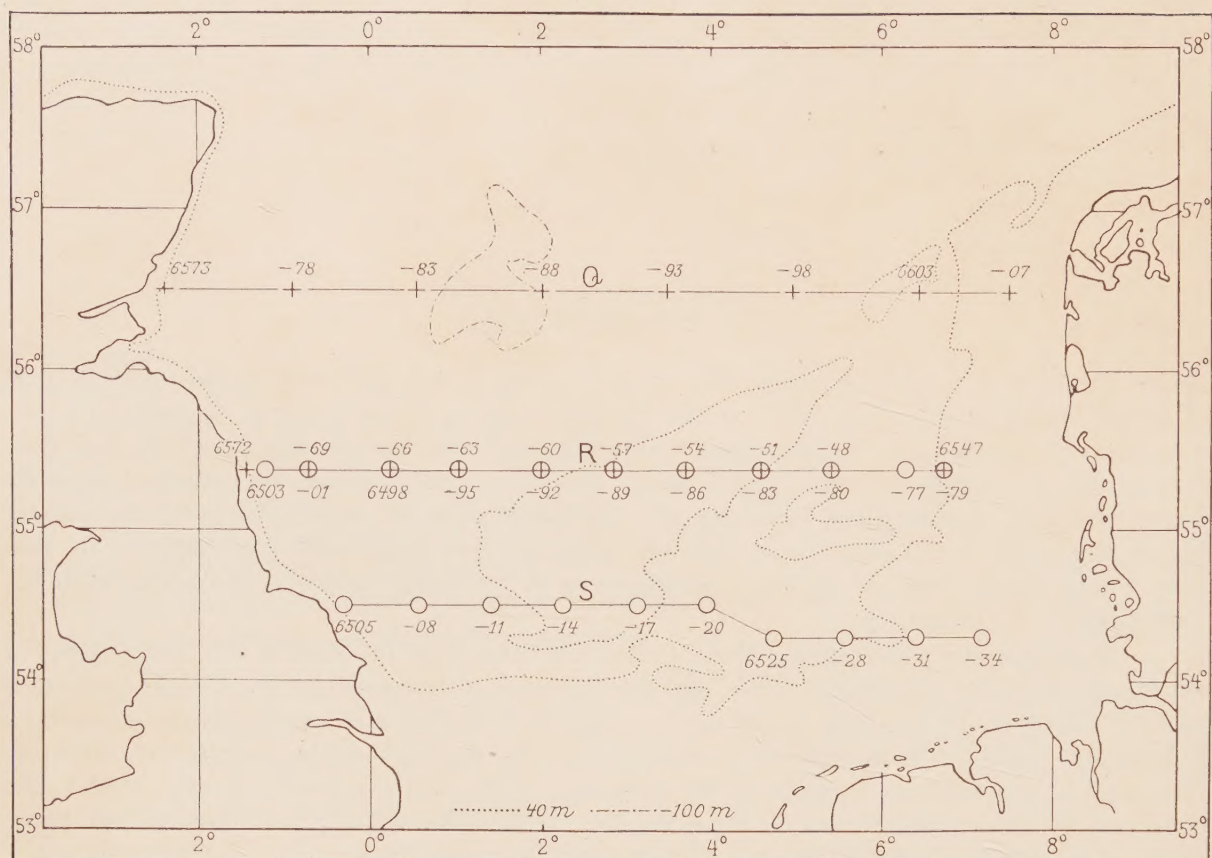


Fig. 1. The locations of the plankton stations in the southern part of the North Sea in May, 1947. At the stations marked ○ collections were made on May 5th—8th. The mark + indicates the stations where collections were made on May 19th—22nd. The signature ⊕ indicates stations where samples were taken in both periods mentioned.

The collections were made in May, 1947. In Sections R and S from May 5th—8th, and in Sections R and Q from May 19th—22nd (Fig. 1). At all plankton stations water samples were taken at the following depths: 0 m., 10 m., 20 m., and 50 m. (or bottom). Besides, surface samples were taken with a plankton net at all stations during the latter collection period and at some few stations in the former period. For the taking of these samples a net of silk gauze No. 25 (diameter 30 cm.) was used.

All plankton samples were preserved in neutralized formalin.

All water samples were subjected to a quantitative examination by means of UTERMÖHL's inverted microscope, a count of organisms being made in 10 and 2 millilitres of the contents of the sample at low and high magnification, respectively. In the case of samples requiring the maximum magnification with a view to morphological studies a centrifuge was used in the making up of the preparations, and an ordinary microscope was employed in the examination. After centrifuging care was taken that water was removed by pipette from the centrifuge tube only to such an extent that a column of water of a height of about 1 cm. was left above the plankton sediment. The sediment was stirred up in this water and a little of the suspension was transferred to the slide which had previously been coated with a thin film of glycerine over an area slightly larger than that of the cover glass. The suspension will be distributed

regularly over the glycerine film and will not overflow it. The water was then evaporated, the glycerine preventing a drying up of the sediment during this process. Another portion of the suspension was then by pipette transferred to the slide, evaporation followed and this was repeated until the entire suspension from the centrifuge tube had been transferred to the slide and the preparation was ready.

Good results are obtained by the method described in the foregoing, but it is rather slow, inasmuch as it requires evaporation for the concentration of the plankton sediment on the slide. When I have made preparations of the same sample by the sedimentation method and by the method here described, I have in all cases with the same amount of certainty been able to ascertain the rare species by both methods. Although this is no actual proof it seems to afford some evidence of the usability of the centrifuge method in quantitative plankton examinations. It must, however, be conceded that it is not a standard method in the sense that the sources of error are the same under all circumstances (cf. SCHMIDT-RIES 1936). The sedimentation method according to UTERMÖHL must, however, be considered such a standard method.

### 3. The Phytoplankton in Relation to Hydrographic Conditions.

From a hydrographical point of view the area under investigation is heterogeneous and on the present basis it is impossible to elucidate all details with regard to the physico-chemical properties of the water masses and the qualitative and quantitative composition of the plankton in relation thereto. As one of the main points the movements of the water may be mentioned:

Current conditions in the North Sea are elucidated in treatises by BÖHNECKE (1922) and TAIT (1937, see Fig. 2). As far as our area is concerned they are in the main characterized by the fact that a southward current along the British coast carries Atlantic water to the area. To be true, during the passage from the Faroe-Shetland channel to the southern part of the North Sea, this water has become somewhat mixed with other water. In the area these water masses move to the eastward and are being further mixed with water from the coastal waters along the southern and eastern sides of the North Sea. In the eastern part of the area the water moves towards the north and out of the area. Swirls of more or less constant magnitude and position occur, thus, immediately off the British coast, in the Dogger Bank area and in the south-eastern part of the North Sea.

Besides the horizontal movements of the water, the vertical — turbulent — movements are of importance for an understanding of the variations in the pelagic vegetation, inasmuch as these movements carry deep water relatively rich in dissolved nutritive salts up to a higher level where light conditions are favourable for photosynthesis and where the growth of the plankton may therefore take place with increased intensity, provided that the turbulence does not carry with it so considerable quantities of detritus or other bottom substances as to weaken the submarine light materially.

When in the spring the upper layers of water are being heated a more or less pronounced stability will occur preventing turbulent movements, and the consequence will be a reduced concentration of nutritive salts in the upper layers, supplies from the bottom layers failing. The stability of the water is therefore of great importance with regard to the condition of growth to which a given stock of plankton is subject. As regards our area stability conditions are shown in diagram in Fig. 3.

The salinity and temperature of the water will appear from Figs. 4–7. The  $S_{\text{‰}}$  is

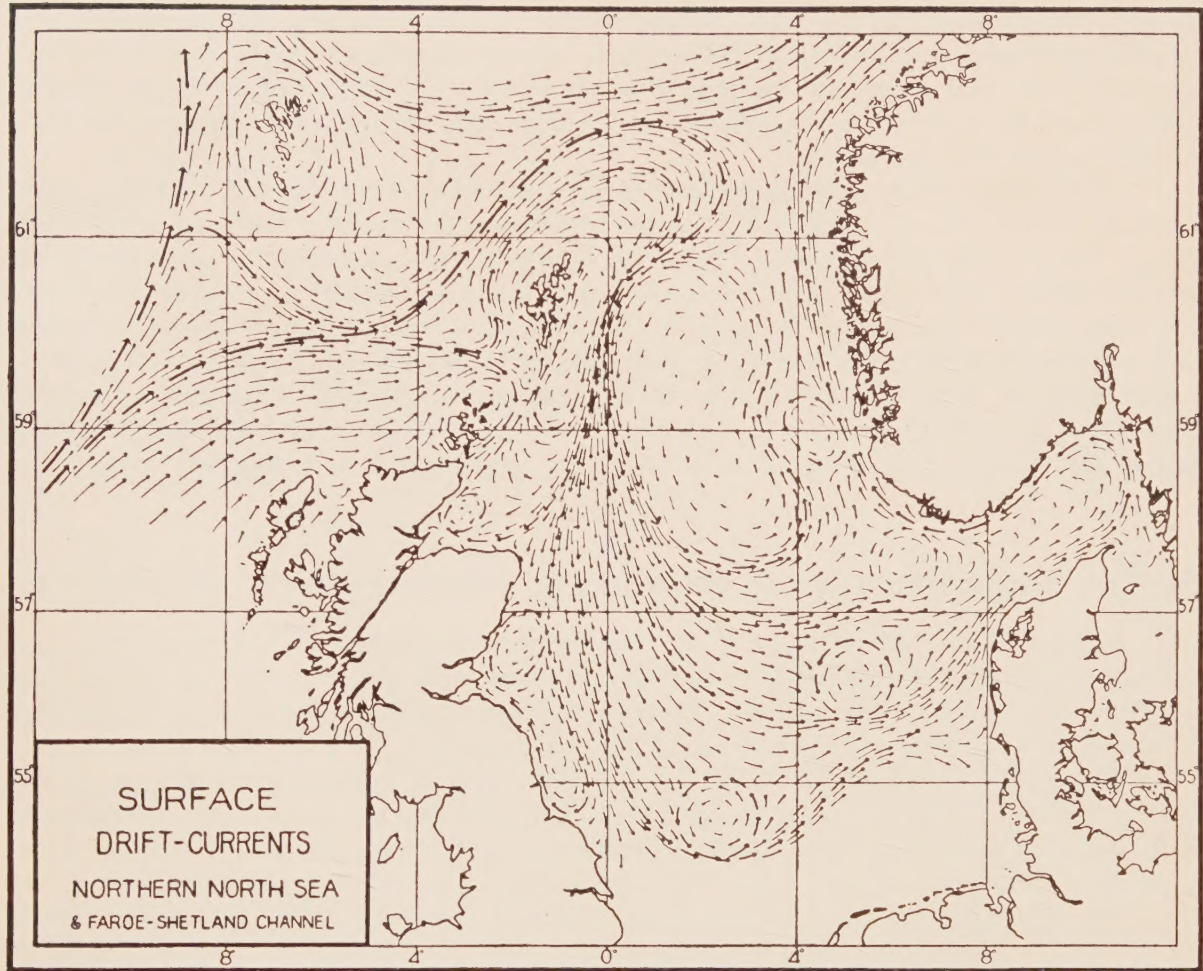


Fig. 2. Current conditions in the northern North Sea (from TAIT 1937).

greatest in the Atlantic water and shows a decline gradually as this water is being mixed with water from the south-easterly coastal waters. During the period of investigation the temperature decreased from west towards east.

The stock of plankton in an area like that dealt with in this treatise is subject to great changes in the course of the year, both qualitatively and quantitatively, and the succession observed is largely simultaneous with changes in hydrographic conditions. In all essentials it follows the same course every year having diatom maxima in the spring and autumn, an intermediate summer maximum of various groups of flagellates and minimum plankton quantities in the winter; it is, however, also dependent upon the different ecological constitutions of the various plankters, certain species being furthered by one combination of living conditions, others by another combination. The autecology of the plankters constitutes a field in which our knowledge so far is rather deficient; as far as many species are concerned it is, however, possible from the conditions under which they commonly occur to obtain some knowledge of the conditions they prefer, but in this manner only general information on the autecology of the species will be derived. Detailed investigations have been made only on a small scale.

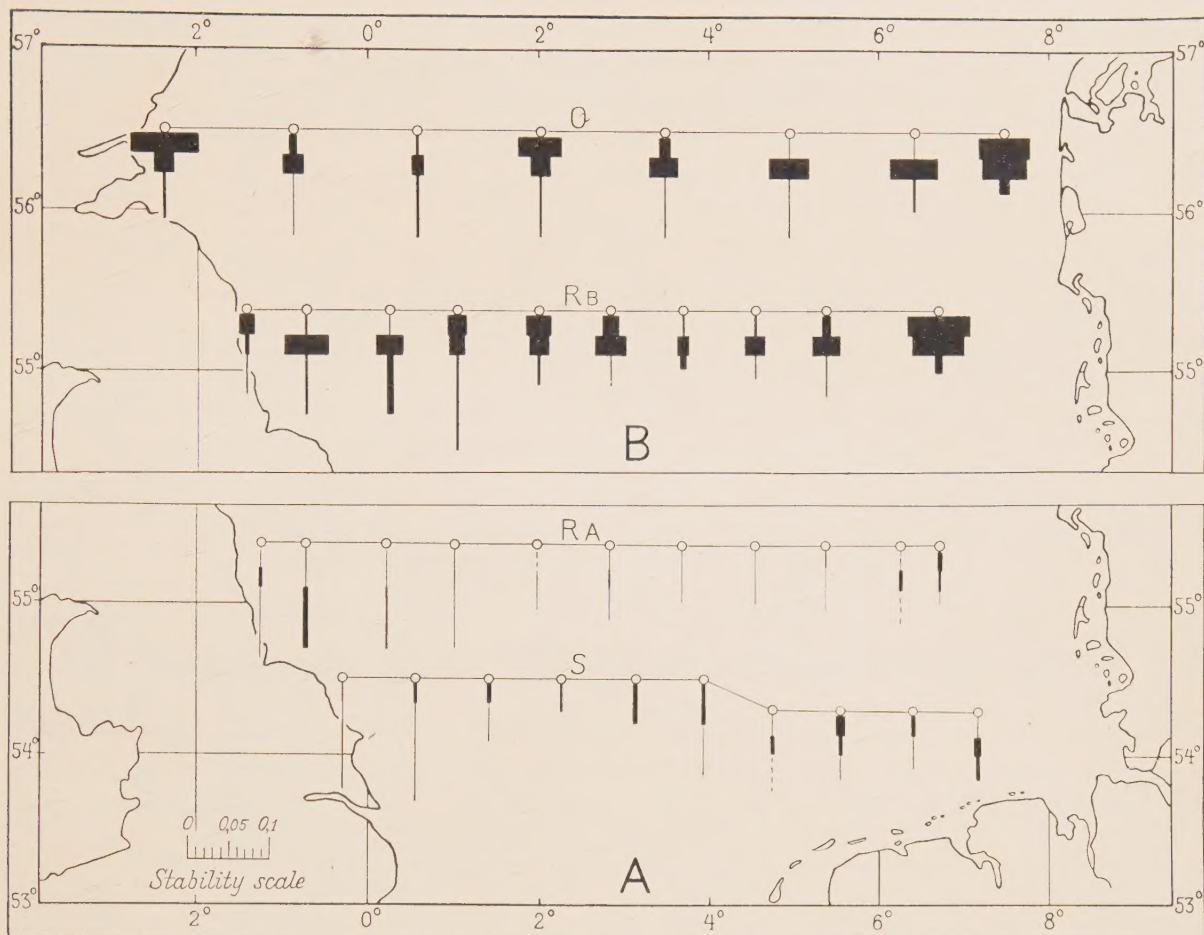


Fig. 3. Graphical reproduction of the stability of the water masses calculated as the increase in  $\sigma_t$  per metre from the surface and downwards (dotted lines indicate negative values). A: May 5-8th; B: May 19-22nd.

#### a. Investigations in Section S, May 7th-8th, 1947.

(Fig. 4; Tables 6-12).

On the western coast station (St. 6505) the water masses are rather homogeneous and we here find a rich diatom flora with *Asterionella japonica*, *Chaetoceros cinctus*, *C. compressus*, *Melosira sulcata*, *Nitzschia delicatissima*, *Skeletonema costatum* and *Thalassiosira decipiens* as the predominant species. The various flagellate groups are very sparsely represented. On the next station (St. 6508) the diatoms likewise constitute the predominant element with particularly *Chaetoceros* species: *C. cinctus*, *C. compressus*, *C. debilis*, and *C. subsecundus* as the most abundant species. A slight stratification of the water appears at this station and at all the subsequent stations in Section S, and the concentration of diatoms is increasing downwards, whereas the relatively few flagellates are most frequent in the upper layers. This station is situated in the southward Atlantic current, while the following stations (St. 6511, 6514 and 6517) are in the Dogger Bank area. Here the water is poor in nutrients and the diatom figures are far lower than those of the previous stations, the frequency figures being likewise small as regards dino-flagellates and other flagellate groups. The two stations closest to the west of Dogger Bank

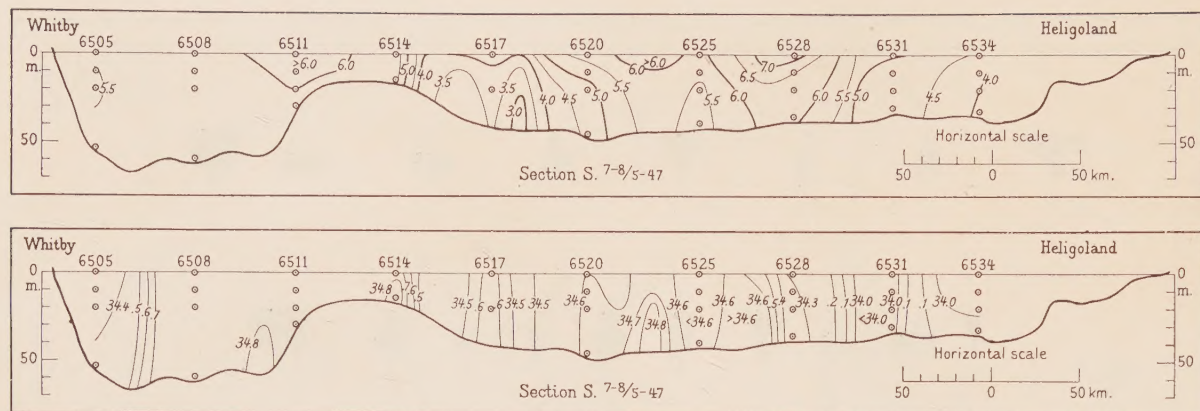


Fig. 4. Temperature and salinity in Section S. May 7th—8th.

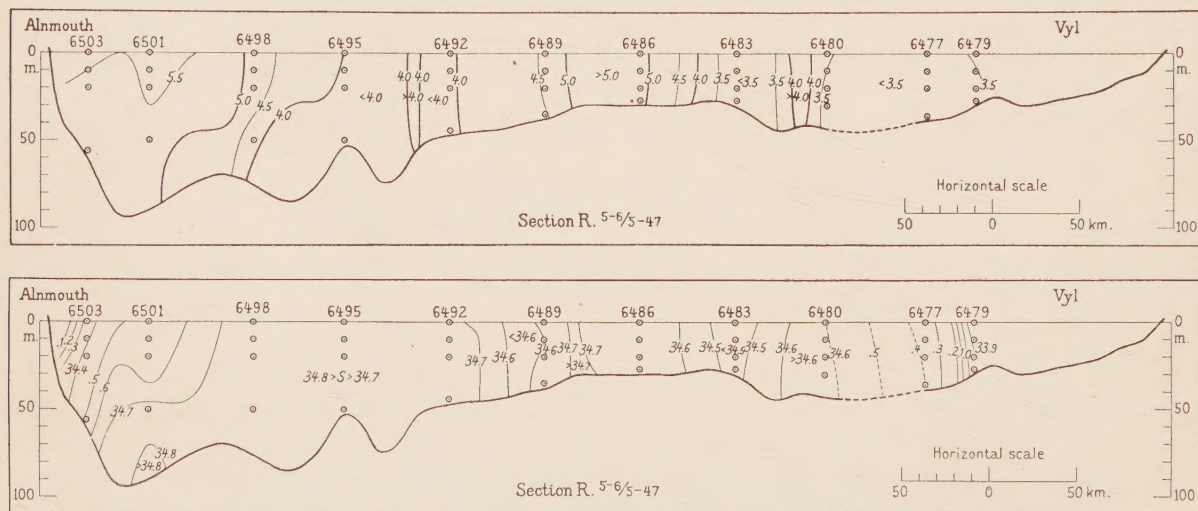


Fig. 5. Temperature and salinity in Section R. May 5th—6th.

(St. 6520 and 6525) show relatively high figures for *Melosira sulcata*, *Nitzschia closterium* and *N. delicatissima*, a fact obviously due to influences from the coastal area to the south. The next station (St. 6528) has a considerably higher temperature than any of the other stations in this section and the water is more stratified. It seems certain that the samples here were taken in an isolated body of water of south-western origin. The plankton flora differs materially from that of the neighbouring stations, e. g. by a preponderance of dinoflagellates such as *Peridinium globulus* var. *ovatum*, *Exuviaella baltica* and other flagellates such as *Bodo marina* and *Carteria* sp., and otherwise by lower frequency figures for a series of diatoms, *Chaetoceros* species, *Nitzschia closterium*, *Skeletonema costatum*, *Thalassionema nitzschioides*, and other species. The diatoms are staying in the lower, the flagellates in the upper layers. At this station where the water is poor in nutritive salts, the plankton succession has reached a more advanced stage than at the other stations of Section S, and the hydrographic conditions: higher temperature and greater stability of the water, are in harmony with this fact.

At the two easterly stations (St. 6531 and 6532), the influence of the coastal water asserts itself by a low  $S_{\text{‰}}$ , and the water is rich in nutrients. The plankton is not particularly abundant

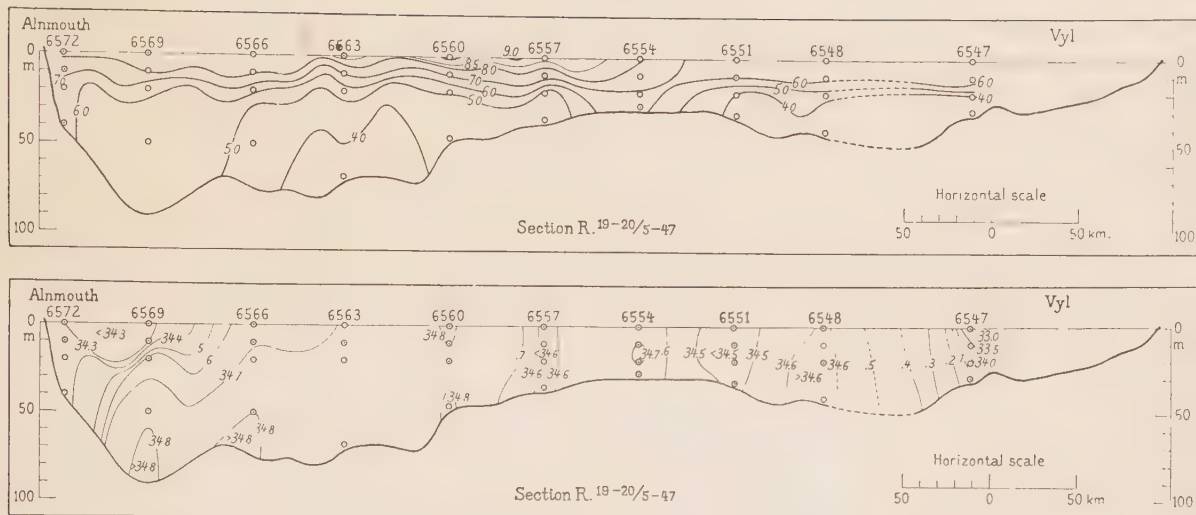


Fig. 6. Temperature and salinity in Section R. May 19th—20th.

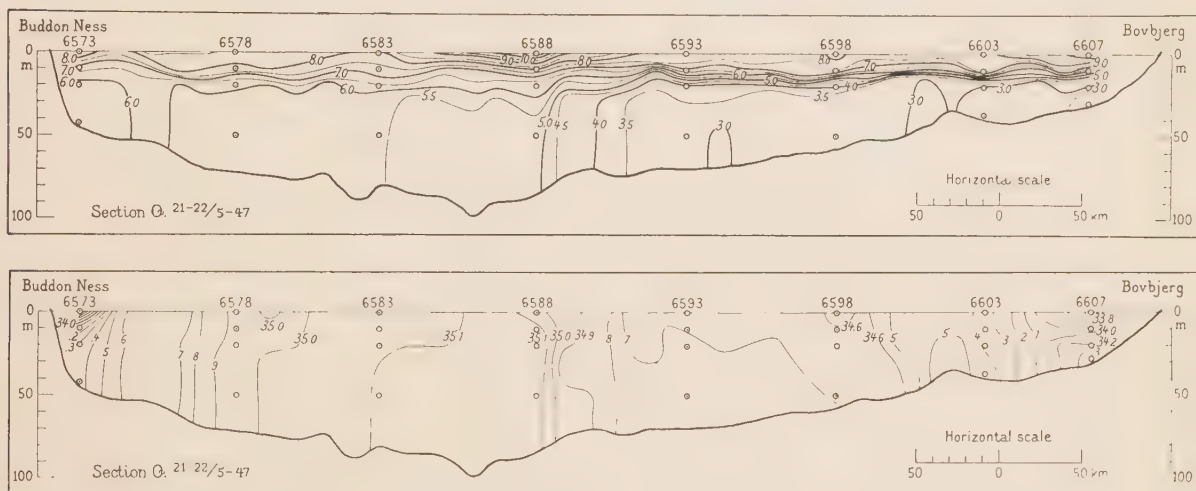


Fig. 7. Temperature and salinity in Section Q. May 21th—22th.

and is being predominated in number by *Chaetoceros* species, with *C. cinctus* and *C. affinis* as the most frequent ones. Otherwise, we find here the same occurrence of coastal species as at stations 6520 and 6525, namely *Melosira sulcata*, *Nitzschia closterium* and *N. delicatissima*; *Biddulphia aurita* is present in relatively great numbers.

#### b. Investigations in Section R, May 5th—6th, 1947.

(Fig. 5; Tables 1—5).

Hydrographically this section differs from the foregoing by the fact that the water masses are more homogeneous. Only at the stations closest to the shores there is a low degree of stability.

The westernmost station (St. 6503) is dominated by *Chaetoceros* species with *C. compressus* as the most frequent one, *Asterionella japonica* and *A. Bleakeleyi*, *Nitzschia delicatissima* and *Skeletonema costatum*. Station 6501 has the same composition of species but the number

of individuals is far smaller. The two stations next following, 6498 and 6495, which are located in the southward Atlantic current have rather homogeneous water. The *Chaetoceros* genus is represented in great numbers with *C. compressus* as the most common species. *Nitzschia delicatissima* is rather frequent, and *Thalassiosira gravida* and *T. Nordenskjöldi* are here found in an occurrence area extending in over the Dogger Bank.

Stations 6492 and 6480 lie in the Dogger area, which as shown by the iso-halines is a hydrographically heterogeneous area. The quantities of phosphate and nitrate are small and the vegetation not particularly well developed and decreasing in quantity towards east. In the homogeneous water it is regularly distributed vertically, but otherwise there are differences with regard to composition of species. In the western part there are considerable patches of *Thalassiosira gravida* and *T. Nordenskjöldi* and of *Chaetoceros* species, and more to the east of *Leptocylindrus minimus* and *Thalassiosira bioculata* var. *raripora*. This heterogeneous character of the flora must be viewed in context with the hydrographic heterogeneity of the area.

At Station 6477 great numbers of *Chaetoceros affinis* occur. This species was likewise numerous in the eastern part of Section S. The similarity in species may possibly be ascribed to the fact that in this area an eddy may exist establishing connection between these localities (Cf. BÖHNECKE, 1922). During the period of investigation the mass occurrence of the species was limited to this part of our area. *Chaetoceros debilis* was also very frequent at station 6477, but apart from these species the diatoms were not present in any number, neither were the flagellates. At Station 6478 *Chaetoceros affinis* showed far smaller numbers of individuals and of *C. debilis* only traces were found. The flora was materially poorer than at the preceding station.

### c. Investigations in Section R, May 19th—20th, 1947.

(Fig. 6; Tables 13—17).

A comparison between the hydrographical conditions during this investigation and that made a fortnight earlier shows a conspicuous increase in temperature in the upper layers. This has involved a considerable degree of stability at all stations, whereas during the previous collection we had homogeneous water masses in the Dogger Bank area and slightly stratified water at the other stations (Fig. 3). As regards the plankton flora the diatoms were heavily reduced in quantity, the dinoflagellates had increased in absolute figures in the eastern part, where particularly *Peridinium trochoideum* was of considerable frequency. Other flagellates, such as *Bodo marina*, *Carteria* sp. and *Monosiga marina* also showed increasing numbers and relatively the flagellates are of greater quantitative importance than was the case at the beginning of May. The occurrence of diatoms has now everywhere — apart from station 6547 where special conditions prevailed — largely been confined to the lower layers, where they are to be found as residues of the numerous stocks observed in certain locations during the first collection of samples. Flagellates and dinoflagellates have their greatest density in the upper layers of water.

At station 6547 a body of water with low salinity has penetrated from the coastal area to the east or south-east, but only above the discontinuity layer. In respect of vegetation it is characterized by a very strong concentration of *Nitzschia closterium*, and considerable numbers of *Chaetoceros affinis*, *Peridinium trochoideum* and *Monosiga marina* are also to be found here. In the lower strata we find a stock of diatoms rich in species, which as regards composition shows only small differences from that recorded at this station at the beginning of May. *Ceratium* is here represented by several species, *C. tripos* being the most frequent one, and also *Phaeocystis* occurs in great concentration, whereas the *Peridinium* species and flagellates as mentioned occurred above the discontinuity layer.

If we disregard station 6547 and consider all the other stations in section R as a whole, our object being to find the causes of the change in the plankton flora occurring simultaneously with or immediately after the stabilization of the water masses, it would seem natural to take note of the fact that nutrition conditions are depreciated by the stabilization. Even if this fact does not appear from the quantities of phosphate and nitrate found (see Tables 1—21), it must be of some importance that the renewal of nutritive salts in the upper strata by vertical currents has ceased. The literature gives many examples showing that this phenomenon has caused — or at any rate coincided with — changes in the diatom stock like those observed. There are, however, other factors which may be presumed to contribute to the rapid decrease in numbers of diatoms, first and foremost their consumption by plankton animals (cf. HARVEY, 1934). In the net samples taken in the surface, mainly at the same places where water samples were taken, zooplankters were found in greatly varying quantities, partly due to the fact that the samples were taken at all times of the day. A comparison between the samples taken by night shows, however, that the quantity of plankton animals was greater at the last ingathering than at the first, and the water samples accordingly contained animal excrements a material part of which consisted of more or less determinable residues of phytoplankters in greatest number at the last ingathering. It can therefore hardly be doubted that consumption has contributed to the decrease in diatoms. This decrease has at all events taken place before the nitrates and phosphates have been exhausted, and cannot therefore very well be due solely to the deterioration of nutrition conditions. The fact that certain groups of flagellates under such circumstances have been able to record increased numbers of individuals, may partly be due to a reduction in the competition between the phytoplankters and partly to ecological causes.

During rapidly decreasing diatom maxima the stock will decline because the cells die or form spores, and dead or sporiform cells predominate in the lower strata under such circumstances. The diatom stock found during the last investigation period did not in any pronounced degree possess this characteristic, and it is therefore improbable that considerable parts have sedimented on the bottom, nor is there reason to believe that any appreciable part has been carried away by movements of the water. Such movements exist, however, and if we consider the individual plankton stations we can at no place be certain that we have had the same masses at both ingatherings. On the contrary, it is quite certain that at some stations we have not, but if we regard the entire area of investigation as a whole, we cannot expect to find a total renewal of the water, as characteristic vegetations were indeed found in the same or approximately the same positions at the last collection as in the first, only the numbers of individuals were on the whole far lower. By way of examples may be mentioned the *Thalassiosira* patch in the western part of the Dogger Bank area and the *Leptocylinthus minimus* occurrence in the eastern part (see Figs. 15—16).

This succession has been ascertained only in respect of Section R, as only in this section plankton was collected in both periods. This section is, however, centrally located and may with regard to this point be considered to represent the entire area. This is confirmed by the investigations in Sections Q and S.

#### d. Investigations in Section Q, May 21st—22nd, 1947.

(Fig. 7; Tables 18—21).

As was the case in Section R during the last collection the water masses in Section Q had stabilized. The degree of stabilization was least at the stations within the Atlantic area.

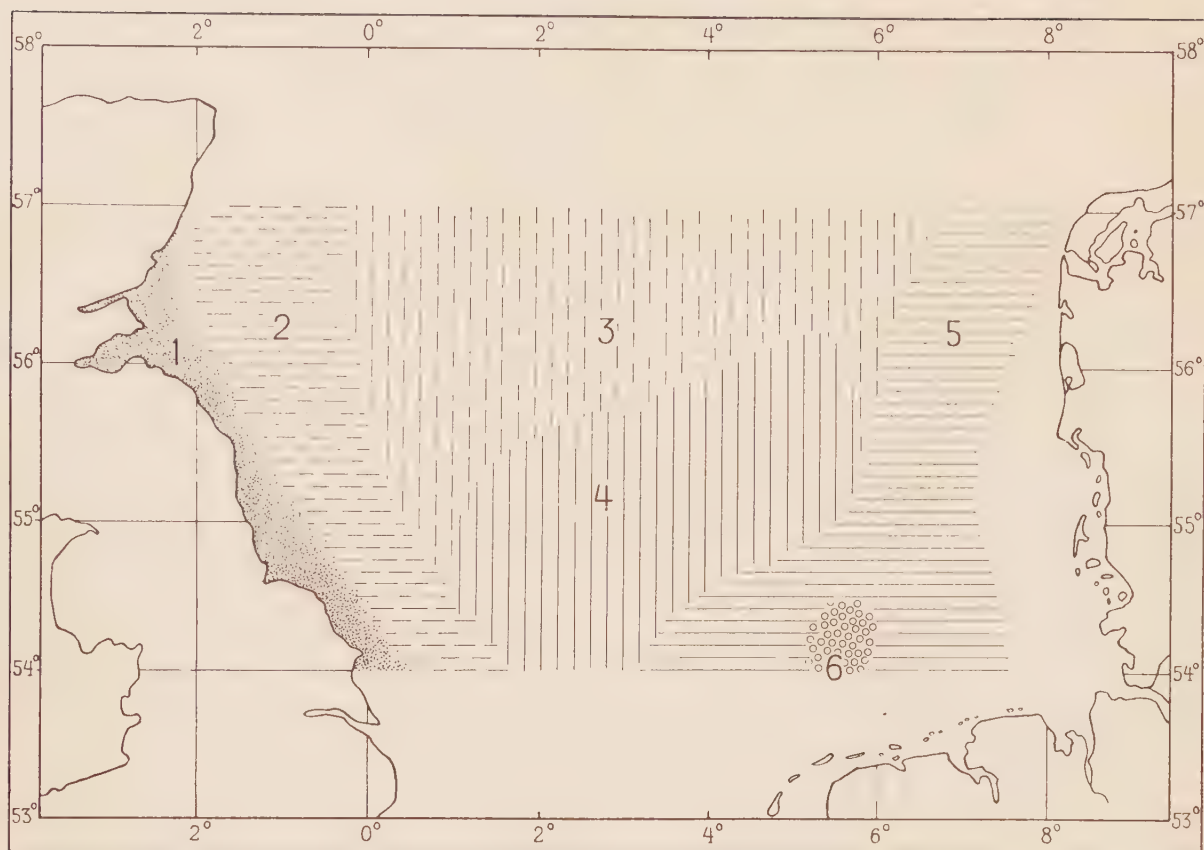


Fig. 8. Phytoplankton areas in the area of investigation in May, 1947.

1: Western coastal zone with *Asterionella japonica* and *Skeletonema costatum*. 2: Southward Atlantic current with *Chaetoceros* species. 3: Central area with predominant flagellate vegetation. 4: The Dogger Bank area with patches of *Thalassiosira gravida*, *T. Nordenskjöldi* and *Leptocylindrus minimus*. 5: South-easterly area with partly littoral plankton vegetation. 6: Patch of *Peridinium globulus* var. *ovatum* and *Exuviaella baltica*.

At the westernmost coastal station (St. 6573) the  $S\text{‰}$  is low in the upper strata and the surface sample shows a very rich diatom flora with *Asterionella japonica*, *Chaetoceros compressus*, *C. cinctus*, *Nitzschia delicatissima*, and *Skeletonema costatum* as the species most rich in individuals; *Peridinium trochoideum* and *Carteria* sp. are also frequent at this station. At the lower levels the quantity of diatoms is heavily reduced, *Melosira sulcata* and *Thalassionema nitzschioides* are most frequent there.

Stations 6578 and 6583 which are in the southward Atlantic current have very small diatom figures originating solely from the bottom layers, where species such as *Skeletonema costatum* and *Thalassionema nitzschioides* are relatively prevalent due to the small quantities of *Chaetoceros* and *Nitzschia* species. The flagellate *Monosiga marina* is frequent in the upper strata at certain places. The next three stations, 6588, 6593 and 6598, are likewise poor in diatoms but have a somewhat larger occurrence of dinoflagellates: *Ceratium* spp., *Exuviaella baltica*, *Peridinium* species — of which *P. trochoideum* is the most numerous — and *Carteria* sp.

The two easterly stations show an increasing although modest number of diatoms with sparse stocks of *Chaetoceros*. *Nitzschia delicatissima* and *Skeletonema costatum* are also present.

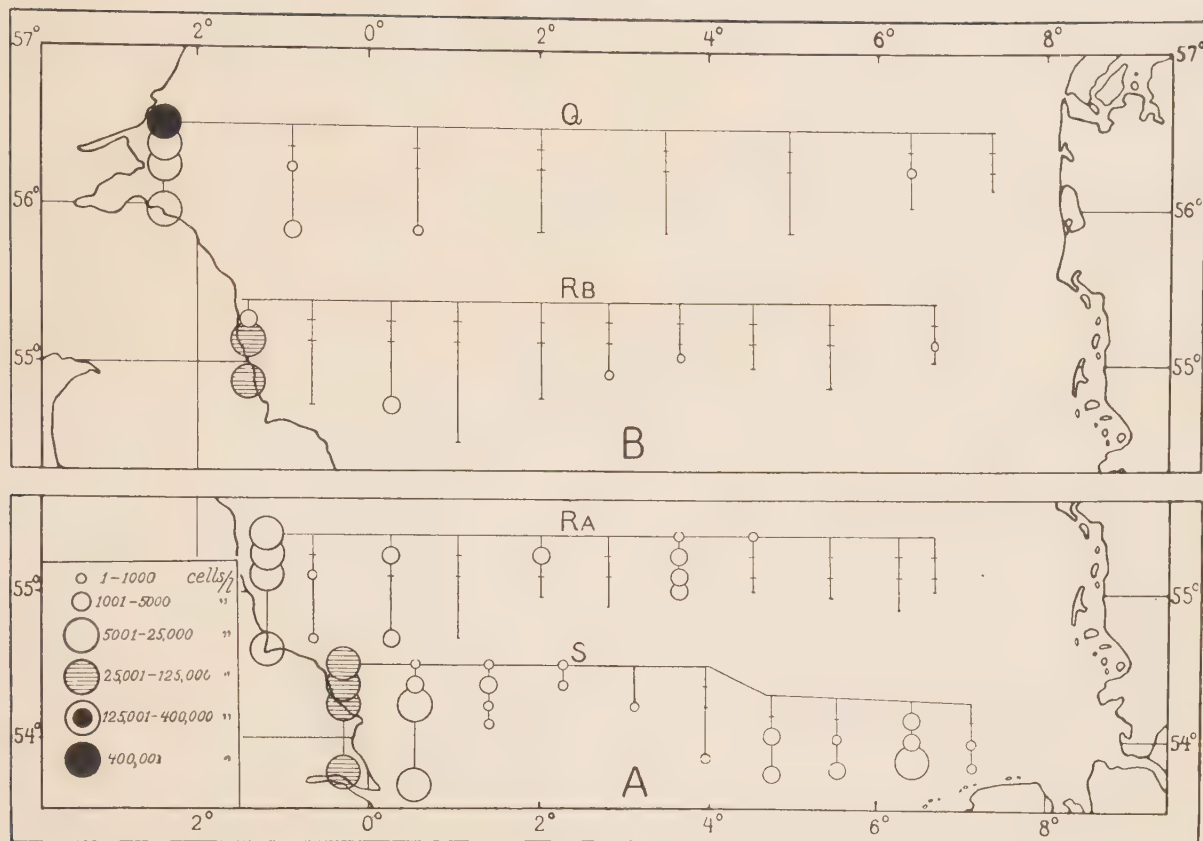


Fig. 9. Distribution of *Asterionella japonica* in May, 1947. A: May 5th-8th; B: May 19th-22nd. In this and the following figs. (10-16, 20) the frequency signatures are placed at the depth from which they originate, viz. 0, 10, 20 and 50 m (or bottom).

in small number. The dinoflagellates have as their most frequent representatives *Dinophysis norvegica* and *Peridinium trochoideum*. Among other flagellates *Carteria* sp. abound.

#### e. Subdivision of the area into vegetation areas.

In the foregoing the description of the plankton flora has been given with a view to the fact that collections were made in two periods, and the differences in flora in the two periods with an interval of 14 days were pointed out and placed in relation to certain hydrographical conditions. A summary of the plankton vegetation of the area is given in the following, subdivided into subareas, each with its floristic characteristics (see Fig. 8).

Starting from the west we have in the form of a narrow belt off the British coast a rich diatom area, particularly characterized by a mass occurrence of *Asterionella japonica* (Fig. 9) and *Skeletonema costatum*. Further, there is a considerable stock of *Chaetoceros* species, which have their strongest concentration in the southward Atlantic current, namely, *C. cinctus*, *C. compressus* and *C. debilis* (Figs. 11 and 12), and finally species are found, which also elsewhere in our area are connected with coastal and shallow waters: *Chaetoceros affinis*, *Melosira sulcata*, *Nitzschia closterium*, *N. delicatissima* (Fig. 10) and *Thalassiosira decipiens*. Special mention may be made of *Asterionella Bleakeleyi* which occurs only in this zone.

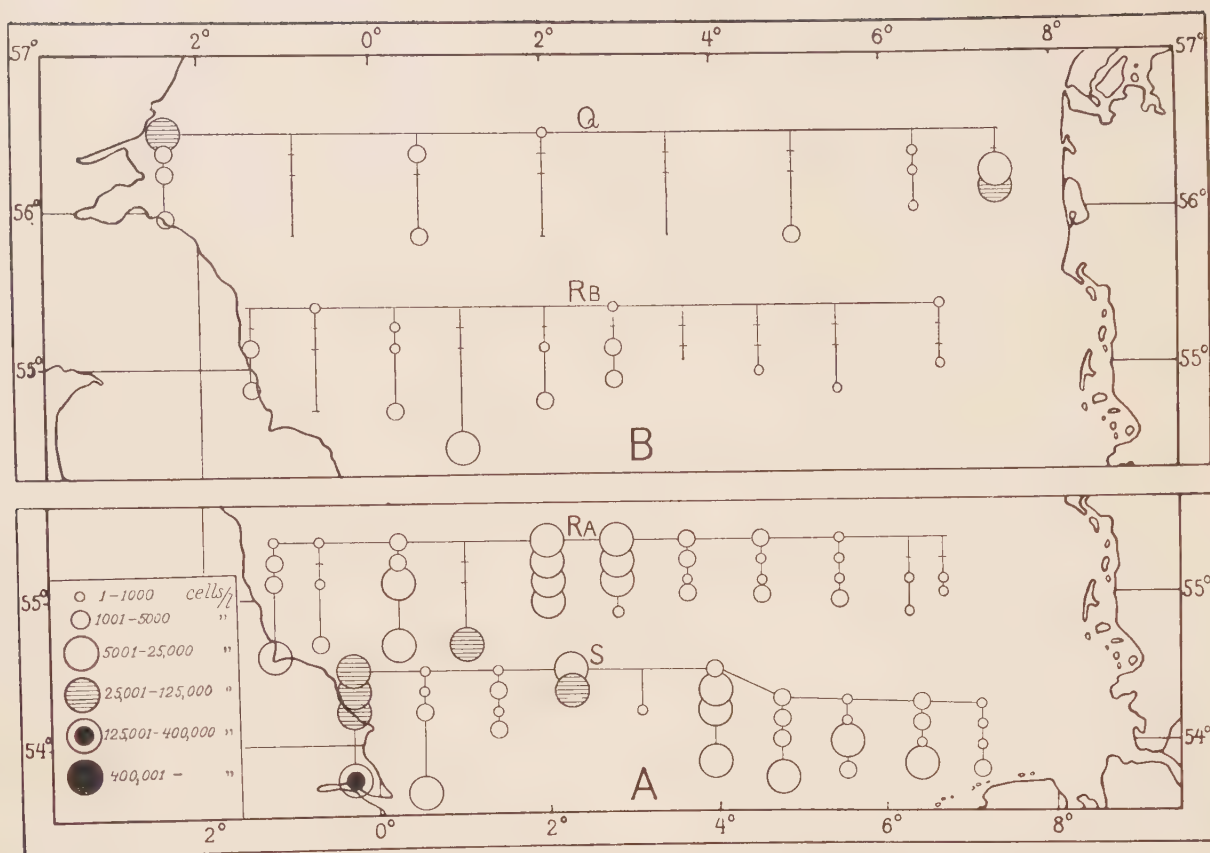


Fig. 10. Distribution of *Nitzschia delicatissima* in May, 1947. A: 5th-8th; B: 19th-22nd.

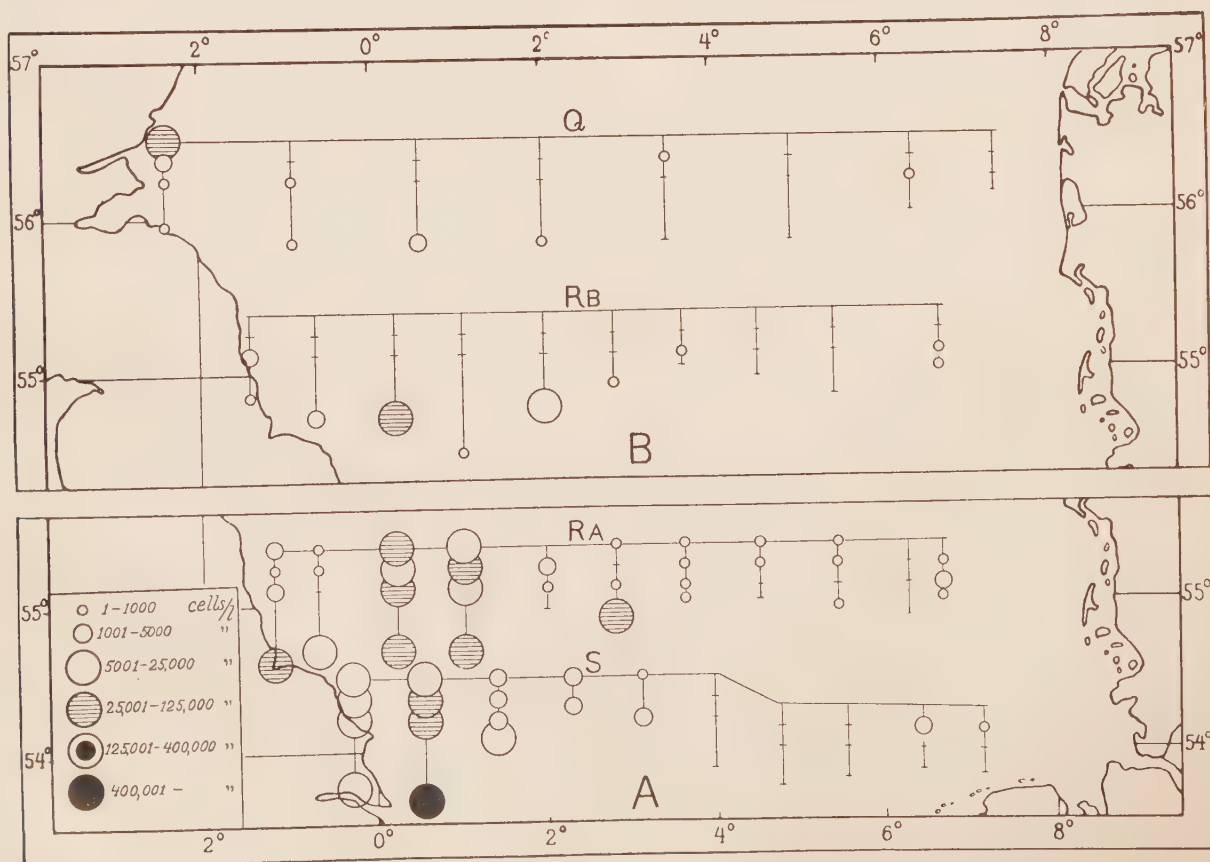


Fig. 11. Distribution of *Chaetoceros compressus* in May, 1947. A: 5th-8th; B: May 19th-22nd.

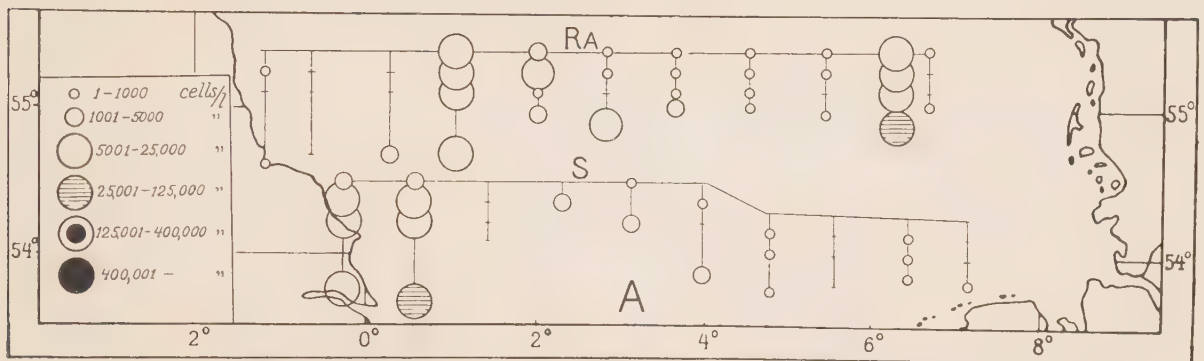
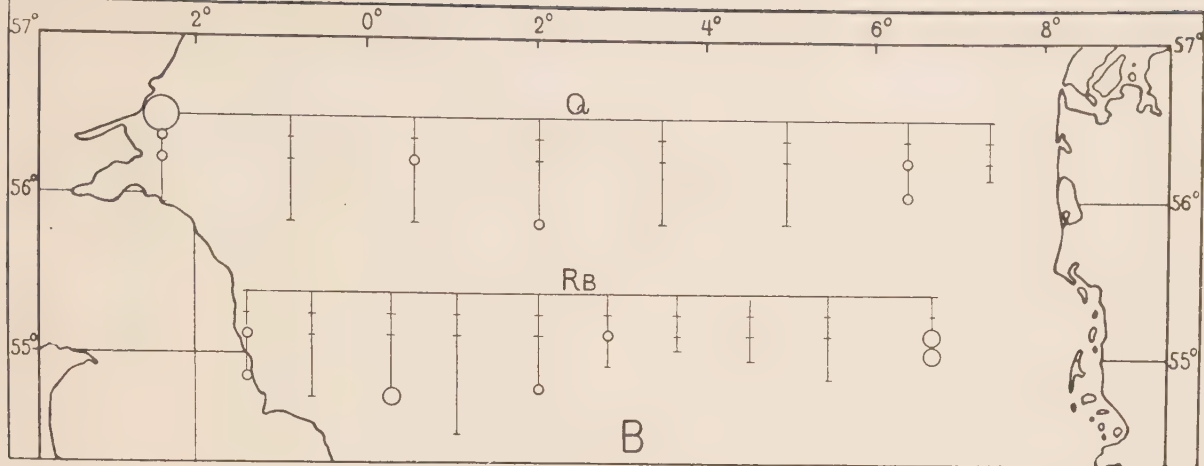


Fig. 12. Distribution of *Chaetoceros debilis* in May, 1947. A: May 5th-8th; B: May 19th-22nd.

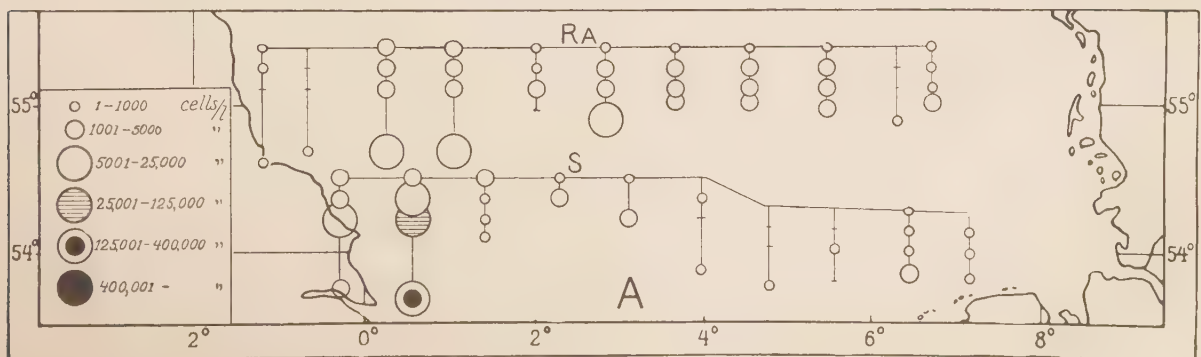
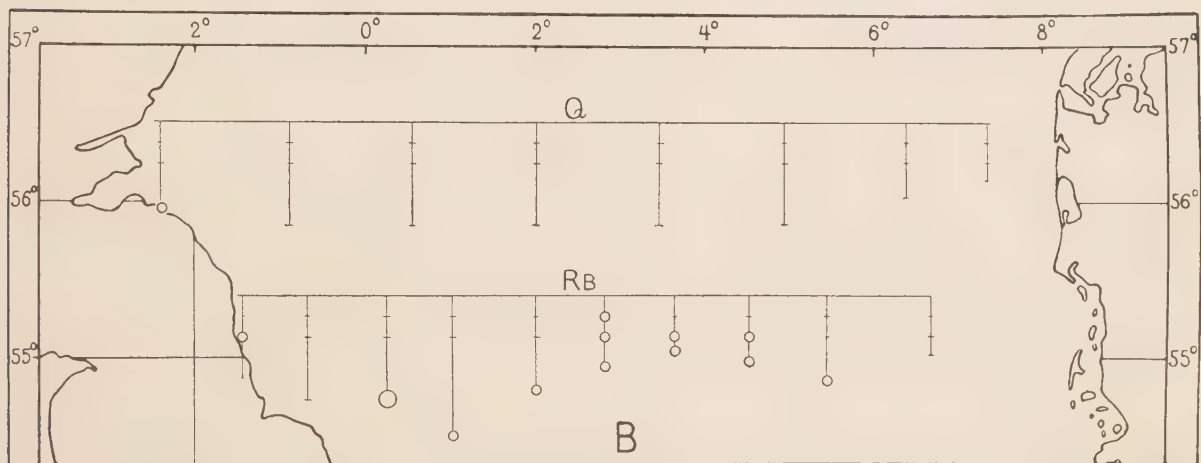


Fig. 13. Distribution of *Chaetoceros subsecundus* in May, 1947. A: May 5th-8th; B: May 19th-22nd.

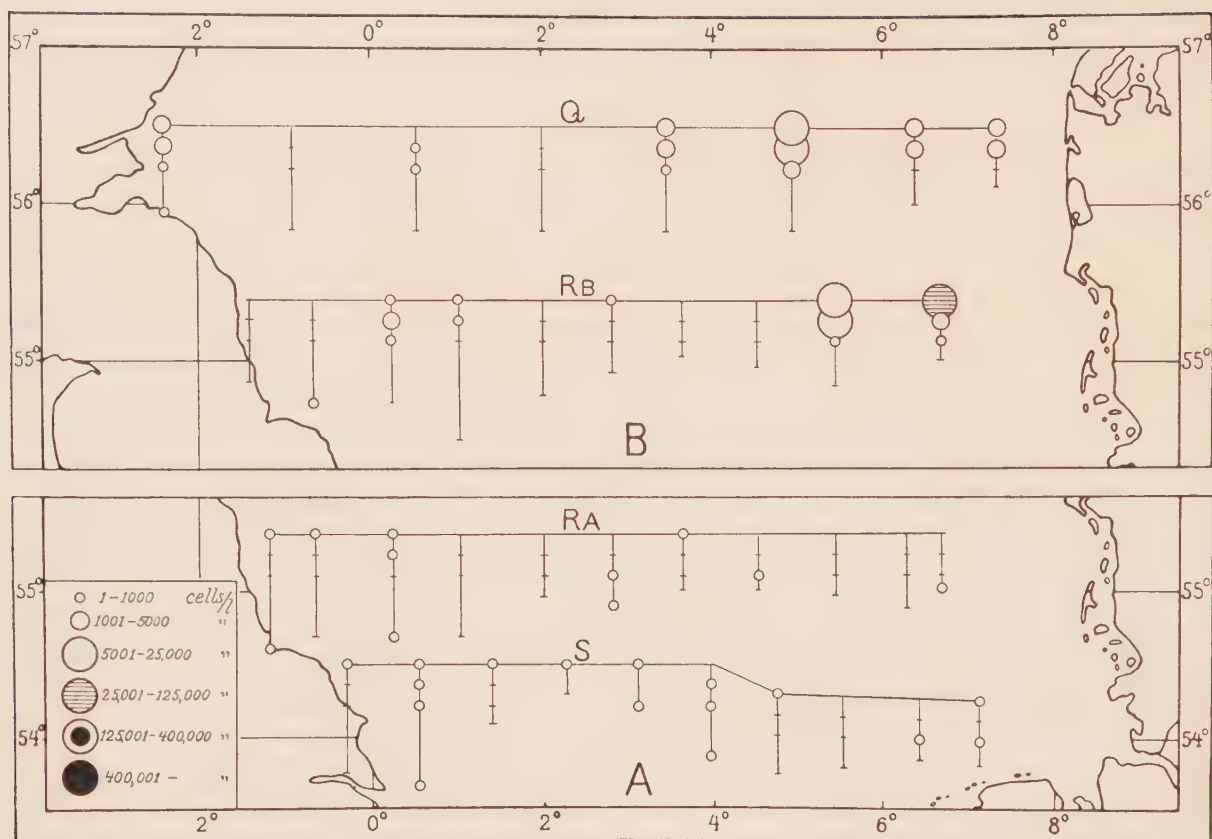


Fig. 14. Distribution of *Peridinium trochoideum* in May, 1947. A: May 5th—8th; B: May 19th—22nd.

East of the coastal zone we have the southward Atlantic current carrying water which has penetrated into the North Sea through the Faroe-Shetland channel and which on its way south to an increasing extent becomes admixed with other water masses. The species most frequently found here are *Chaetoceros cinctus*, *C. compressus*, *C. debilis* and *C. subsecundus* (Figs. 11—13), and also *Melosira sulcata*. These species showed a considerable decline during the period of investigation, whereas *Monosiga marina* (Fig. 20) and other flagellates increased in frequency. Species, rare but characteristic of the Atlantic water are *Thalassiothrix longissima* and *Antosphaera robusta*.

In the central part of the North Sea north of the Dogger Bank no samples were taken at the beginning of May, and the investigation thus comprises only the period in which the diatom populations had become heavily reduced. The peculiar occurrence of *Coscinodiscus concinnus* mentioned in more detail in another chapter (see p. 27) covers this area and parts of the adjacent areas. Otherwise the diatoms were extremely few and the small numbers of dinoflagellates become relatively conspicuous. *Peridinium trochoideum* is the most frequent species (Fig. 14), *Exuviaella baltica*, *Ceratium* and *Dinophysis* species are rarer, but the highest frequency figures are found in respect of *Carteria* sp. and other flagellates.

In the Dogger Bank area the flora is rather heterogeneous. Thus, on the boundary of the Atlantic current we find considerable concentrations of the *Chaetoceros* species frequent in these waters, and also of *Thalassiosira gravis* (Fig. 15) and *T. Nordenskjöldi*. Isolated

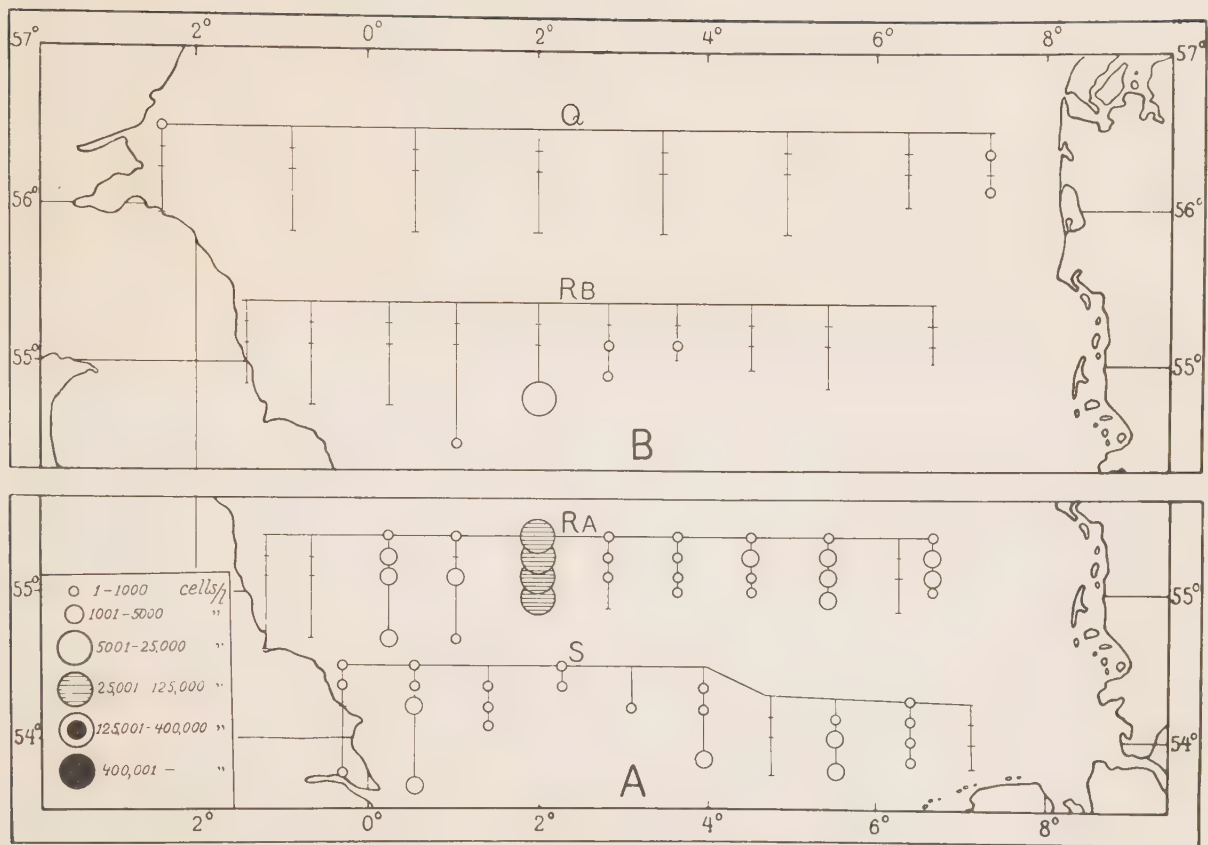


Fig. 15. Distribution of *Thalassiosira gravida* in May, 1947. A: May 5th—8th; B: May 19th—22nd.

occurrences were found of *Leptocylindrus minimus* (Fig. 16), *Thalassiosira decipiens*, *T. bioculata* var. *raripora*, *Nitzschia delicatissima* (Fig. 10), *N. seriata* and *Peridinium trochoideum* (Fig. 14). The following species are common, but occur in less density: *Coscinodiscus concinnus* (Fig. 23), *Melosira sulcata*, *Nitzschia closterium*, *Rhizosolenia hebetata* f. *semispina*, *Dinophysis* species, *Bodo marina*, *Monosiga marina* (Fig. 20), *Phaeocystis* sp. (Fig. 17) and a group of unclassified flagellates. Further, scattered occurrences of small numbers of *Chaetoceros danicus*, *C. borealis*, *C. densus*, *Ditylum Brightwelli*, *Rhizosolenia fragilissima*, *Peridinium globulus* var. *ovatum*, *Coccolithus Huxleyi*, and others were also found here.

The south-eastern area comprises the part of the investigation area closest to the 40-metre curve. The current here mainly sets in a northerly direction and the water is admixed with water of relatively low salinity from the shallow coast stretches to the south and east. The plankton is influenced by this fact although there are no large stock of neritic species as was the case in the coastal zone to the west, where *Asterionella japonica* and *Skeletonema costatum* recorded very high frequency figures. This must be ascribed to the fact that collections in the eastern parts were not made right up to the coast, where these two species are likely to occur in great concentration (GRØNTVED, 1949).

In the southern part of this area the temperature was relatively high. A number of species may be stated to be characteristic of this sector (mention having previously been made of the typical vegetation at station 6528), they are: *Asterionella japonica* (Fig. 9), *Cerataulina Bergoni*,

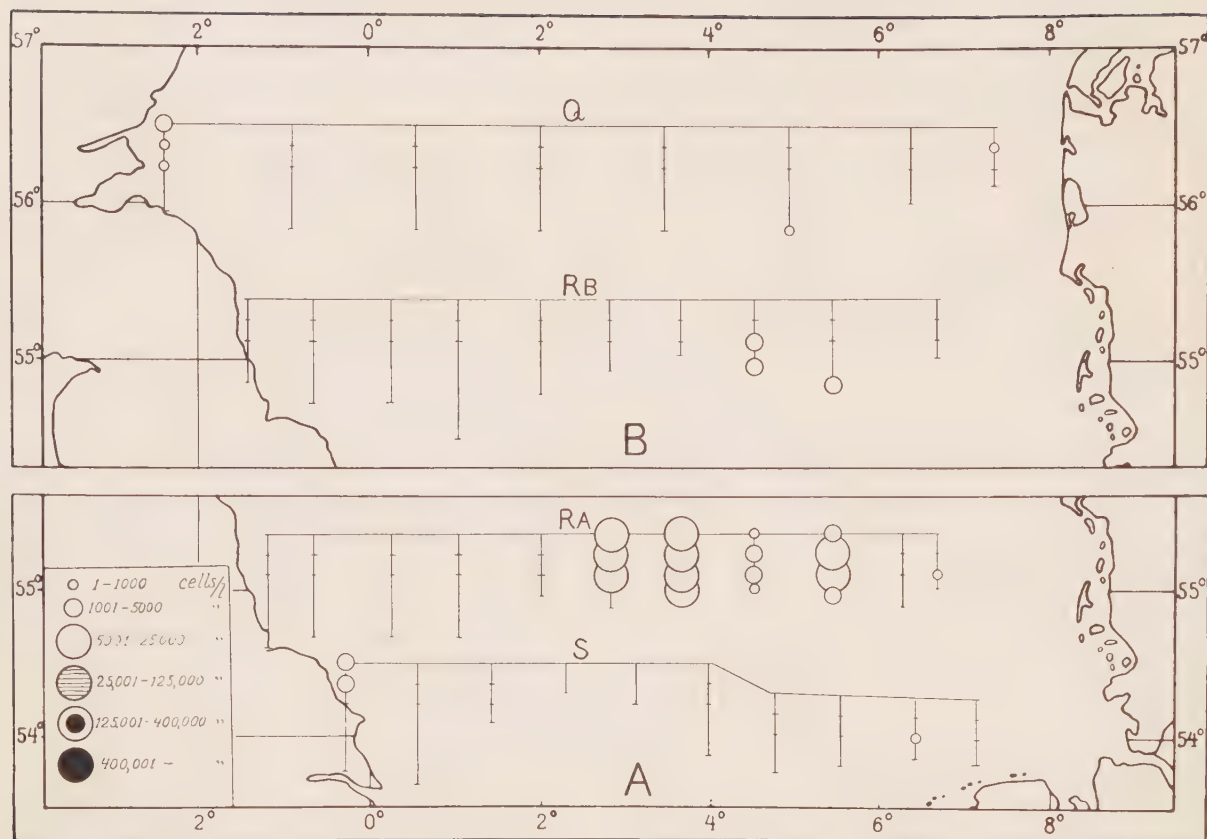


Fig. 16. Distribution of *Leptocylindrus minimus* in May, 1947. A: May 5th—8th; B: May 19th—22nd.

*Chaetoceros danicus*, *Melosira sulcata*, *Nitzschia seriata*, *Rhizosolenia setigera*, *R. imbricata* var. *Shrubsolei*, and *Peridinium globulus* var. *ovatum*. In the eastern part the vegetation partakes of a somewhat different character. Here we may mention species, such as, *Chaetoceros borealis*, *C. debilis*, *Coscinodiscus concinnus* (Fig. 23), *Rhizosolenia alata*, *Ceratium tripos*, *Peridinium trochoideum* (Fig. 14), and *Monosiga marina* (Fig. 20). As species common to both sectors may be mentioned: *Chaetoceros affinis*, *Rhizosolenia hebetata* f. *semispina*, *Nitzschia closterium*, *N. delicatissima* (Fig. 10), *Phaeocystis* sp. (Fig. 17) and the characteristic littoral species *Biddulphia aurita* and *B. rhombus*, which, however, are found only in scattered occurrences.

#### 4. Comparison with the results of the international investigations in May, 1948.

For our area we have a series of earlier investigations of great value, but their results are only little suitable for a comparison with ours, inasmuch as the individual investigations cover only small parts of the area or were made at other seasons than ours. Further, in respect of most of them other methods have been used (the net method, the Continuous Plankton Recorder) in the collection of plankton. Among such works may be mentioned the international investi-

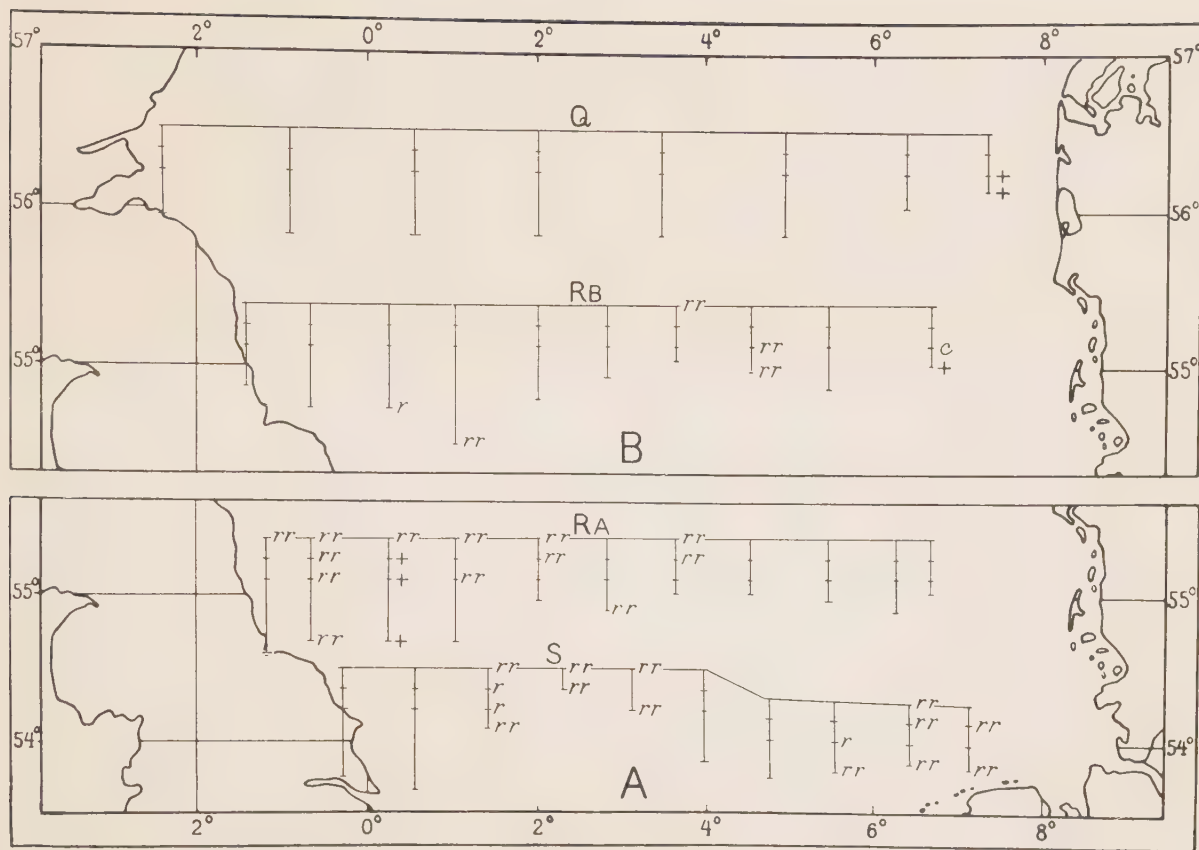


Fig. 17. Distribution of *Phaeocystis* sp. in May, 1947. A: May 5th—8th; B: May 19th—22nd. As far as this species is concerned no count has been made of the cells. The letter symbols indicate the estimate degrees of frequency at different depths (rr = very rare; r = rare; + = rather common; c = common; cc = very common. Vertical scale: 2.7 mm = 10 m).

gations published in Bull. des Résultats etc., 1902—1905, and in Bull. Trimestriel etc., 1905—1908; also APSTEIN (1905), GRAN (1915), WULFF (1925), SAVAGE and HARDY (1935), SAVAGE and WIMPENNY (1936), LUCAS (1940, 1941, 1942), and WIMPENNY (1949).

On the other hand, the results of the international investigation in 1948 (BRAARUD *et al.*, 1952) lend themselves very well to a comparison with ours, collections having in both cases been made in practically the same localities, the same methods having been used for the ingathering and preservation of the samples, and the time of collection being May 4th—10th, 1948, coinciding with our first collection period as regards sections R and S.

The plankton in the British coastal zone had in both years diatoms as the predominant element, and essentially the same species: *Asterionella japonica*, *Chaetoceros* spp., *Melosira sulcata*, and *Skeletonema costatum*. Further may be mentioned as a common feature that the coastal stations in Sections Q and S were considerably richer in plankton than the coastal stations in the R Section.

During the first collection period on 1947 considerable quantities of the diatoms predominating in the coastal zone were found in the southward Atlantic current. In the latter half of May, 1947, and during the collection in 1948 this population had become heavily reduced, whereas dinoflagellates and other groups of flagellates showed increased numbers of individuals, particularly pronounced in 1948, when *Exuviaella baltica* occurred in great density.

As regards the Dogger Bank area, where at the beginning of May, 1947, we found certain diatom concentrations, partly as isolated occurrences (*Thalassiosira gravida*, *T. bioculata* var. *rari-pora*, *Leptocylindrus minimus*) and at the end of the month a heavy reduction in these species and an increase in the stock of flagellates, we find in 1948 conditions identical with those of the Atlantic current, i. e. a small stock of diatoms — the principal component being *Rhizosolenia imbricata* var. *Shrubsolei*, which occurs in a limited area — dinoflagellates with *Exuviaella baltica* as the most frequent species, form a strong characteristic in the plankton picture.

In the central area north of Dogger the vegetation is slight in both years and flagellates predominate. In 1948 *Exuviaella baltica* was the most common species and *Coccolithus Huxleyi* common although with low frequency. In the 1947 material the former species showed only scattered occurrences and the latter was not observed. In this connection it must be mentioned that in 1947 collections in this section were made only on May 21st—22nd.

In both years the southeasterly coastal area was characterized by the fact that diatoms formed the principal element of the vegetation, particularly *Chaetoceros* species.

On the whole, the pelagic vegetation of the two years showed identical features. As a difference of more special character may be mentioned the occurrence of *Exuviaella baltica*. In 1948 this species was spread over the entire area, at certain localities in great density, whereas in our investigations it occurred only in scattered localities and always with low frequency.

If we compare the vegetations at the beginning of May of the two years, disregarding the coastal zones, we find a pronounced preponderance of diatoms in 1947. In that year the plankton succession had not got beyond the *Chaetoceros* stage by that time. The plankton from the beginning of May, 1948, and from the latter half of that month in 1947, shows, however, great similarity with regard to succession. At these times the diatom vegetation had become greatly diminished and the stock of flagellates assumed considerable proportions.

With regard to the causes of the delayed plankton succession in 1947 as compared with that of 1948, it may be pointed out that hydrographic conditions also differed in the two years. The temperature was extraordinarily low in the spring of 1947 (cf. THOMSEN, 1949), and the water masses were rather homogeneous during the collection from May 5th to 8th; during the collection May 19th—22nd a high degree of stability had been attained. In 1948 on the other hand, the water masses were to a certain extent stabilized already by May 6th—10th when collection took place. The differences indicated in the plankton succession at the beginning of May of the two years are presumably due to differences in the stability of the water masses, and it is probable that also in 1948 consumption has been a contributory cause of the reduction in the stock of diatoms.

## 5. Remarks on taxonomy and distribution of the species.

### a. Diatoms.

*Actinoptylchus undulatus* (BAIL.) RALFS. This littoral species not rarely occurs in the plankton particularly at the shallow stations, but always with small frequency figures.

*Asterionella Bleakeleyi* W. SM. occurs only in the British coastal zone, in a sample from Station 6503 with a number of 37,000 cells per litre, the other occurrences are few in number.

*A. japonica* CL. The mass occurrence of this species is limited to the western coastal zone, where at Station 6573 it has its maximum frequency (700,000 cells per litre) in the surface. In the rest of the area there are only scattered occurrences which are most numerous in the south-eastern part (Fig. 9).

*A. kariana* GRUN. Of this species which has not previously been found in the North Sea some

small occurrences were recorded. They were most frequent in the south-eastern area and more scattered in the rest of the area of investigation.

*Bacteriastrum hyalinum* LAUD. Small numbers of this species were observed in a few localities in the western and southern parts.

*Biddulphia aurita* (LYNGB.) BRÉB. & GOD. occurs extensively but in small numbers in the coastal waters to the south and east. More scattered occurrences are found on the Dogger Bank.

*B. mobiliensis* BAIL. and *B. regia* (SCHULTZE) OSTF. were recorded only as casual occurrences in a few localities.

*B. rhombus* (EHRB.) W. SM. and *B. sinensis* GREV. are likewise represented in small number and only in the south-eastern part.

*Cerataulina Bergoni* PERAG. This species occurs most frequently at the south-eastern stations and more scattered in the Dogger Bank area.

Of the genus *Chaetoceros* EHRENBURG the following species were found: *C. affinis* LAUD., *C. atlanticus* CL., *C. borealis* BAIL., *C. brevis* SCHÜTT, *C. ceratosporum* OSTF., *C. cinctus* GRAN, *C. compressus* LAUD., *C. constrictus* GRAN, *C. crinitus* SCHÜTT, *C. curvisetus* CL., *C. danicus* CL., *C. debilis* CL., *C. decipiens* CL., *C. densus* CL., *C. didymus* EHR., *C. furcellatus* BAIL., *C. gracilis* SCHÜTT, *C. lacinosus* SCHÜTT, *C. septentrionalis* OESTR., *C. sessilis* GRÖNTVED, *C. similis* CL., *C. socialis* LAUD., *C. subsecundus* (GRUN.) HUSTEDT, *C. teres* CL., *C. Wighami* BRIGHTW.

The most numerous species are *C. compressus*, *C. debilis* and *C. subsecundus*, the occurrences of which are shown in Figs. 11—13. They are most frequent in the southward Atlantic current and the adjacent areas. *C. debilis* had also a numerically large occurrence in the eastern area. *C. cinctus* occurrences are of similar type and likewise of considerable frequency. *C. affinis* is very numerous at the eastern coastal stations.

*C. borealis*, *C. decipiens* and *C. densus* occur in rather small numbers but the localities are distributed with some regularity over the southern part of the area. *C. atlanticus* and *C. socialis* occur only at the south-eastern coastal stations. *C. danicus* is to be found there and also in the Dogger Bank area.

Other *Chaetoceros* species occur only in small numbers and in scattered localities, most frequently in the southern part of the Atlantic current and in the adjacent areas. It may be noticed that the determination of species as regards *C. ceratosporum* and *C. gracilis* is not quite certain. No resting spores were found and such spores are required for a definite distinction between these two solitary species. It may further be added that *C. brevis*, *C. furcellatus* and *C. sessilis* were not observed in the water samples but were found in the net samples.

*Coscinodiscus centralis* EHRB., occurred in small numbers in the southward Atlantic current and on the Dogger Bank.

*C. concinnus* W. SM. The distribution of this species will appear from Fig. 23. It is most frequent in the eastern part of the area. Its peculiar occurrence on the surface is mentioned in Chapter 6.

*C. exentricus* EHRB., *C. Grani* GOUGH, *C. marginatus* EHRB., and *C. oculus iridis* EHRB. These species were recorded only in few localities and always in small concentration.

*C. radiatus* EHRB. was found in a number of localities in the Dogger Bank area, but always in small numbers in the samples.

*Coscinosira polychorda* GRAN. The sparse occurrences of this species were confined to the southern littoral stations.

*Dactyliosolen mediterraneus* PERAG. A few individuals of this species were observed in the Atlantic current (St. 6583).

*Ditylum Brightwelli* (WEST) GRUN. had its maximum frequency in the southern part of the Atlantic current (maximum 11,000 cells per litre at Station 6508), and scattered occurrences on the Dogger Bank.

*Eucampia zoodiacus* EHRB. A few individuals of this species were found at Stations 6547 and 6578.

*Guinardia flaccida* (CASTRAC.) PERAG. was only recorded at the Dogger Station 6483.

*Hyalodiscus scoticus* (KÜTZ.) GRUN. A numerically small occurrence of this species was observed on the Dogger Bank.

*Leptocylindrus danicus* CL. had sparse occurrences in the coastal districts.

*L. minimus* GRAN occurred in considerable concentration (up to 18,000 cells per litre) in a small area in the northern part of Dogger Bank (Fig. 16), and also with lower frequency figures in the stations near the coasts.

*Melosira italica* (EHRB.) KÜTZ. A *Melosira* species occurring in the eastern and a couple of the southern stations has — without absolute certainty — been referred to this species. These occurrences must no doubt be ascribed to influences from the actual littoral waters to the south and east.

*M. sulcata* (EHRB.) KÜTZ. This tychopelagic species showed considerable frequencies in the plankton samples from the southern stations (up to 27,000 cells per litre at Station 6525) and along the British coast. Otherwise scattered occurrences were observed throughout the area.

*Nitzschia closterium* (EHRB.) W. SM. This species had its greatest frequency in the coastal zones. A very large stock (1,097,000 cells per litre) was found at St. 6547 in a water mass which had penetrated out from the nearby coasts. In other parts of the area the species was only of sparse occurrence.

*N. delicatissima* CL. The occurrence of this species will appear from Fig. 10. It has its greatest frequency in the western zone and in the Dogger Bank area.

*N. sp. parva* in *Phaeocystis*. Small, needle-shaped, solitary *Nitzschia* individuals which are found only in *Phaeocystis* colonies where they are numerous, but due to their lumpwise presence in the preparations it has been impossible to count them. So far no real morphological studies have been made of these forms, and therefore the *nomen nudum* introduced by MIELCK (1911) is being used here. Both the latter author and GRAN (1915) have found these forms within the same area and under the same circumstances in which they appeared in our samples.

*N. seriata* CL. This species is rather wide-spread in the coastal zones and particularly in the west. In the Dogger Bank area it is more scattered, but at Station 6554 a patch of considerable concentration was recorded (24,000 cells per litre).

*Podosira stelliger* (BAIL.) MANN. This littoral species was found in the plankton at some coastal stations.

The *Rhizosolenia* species all occur with small numbers of individuals, but the occurrences differ somewhat.

*R. alata* (GRUN.) JÖRGENS. has its greatest frequency in the eastern part.

*R. fragilissima* BERG. is most frequent in the western zone.

*R. hebetata* f. *semispina* (HENSEN) GRAN shows scattered occurrences all over the area but is most numerous at the coastal stations.

*R. imbricata* var. *Shrubsolei* (CL.) SCHRÖDER is sparse. It is mostly found in the southern coastal area. In May, 1948, this species showed considerable concentration in the Dogger Bank area.

*R. setigera* BRIGHTW., *R. Stollerfothi* PERAG. and *R. styliiformis* BRIGHTW. Only few, scattered occurrences of these species were recorded.

*Skeletonema costatum* (GREV.) CL. This neritic species together with *Asterionella japonica* predominate in the western coastal zone and in the southern part of the Atlantic current. Its occurrence in mass is limited to this area. An especially vigorous development at Station 6573 (743,000 cells per litre) during the second period of collection was probably a local phenomenon in connection with coastal water of low salinity. Otherwise, the species occurs scattered in the Dogger Bank area and with constant but not numerous occurrences in the south-eastern coastal sector.

*Thalassionema nitzschioides* GRUN. A neritic species which is wide-spread throughout the investigation area. It is, however, most frequent in the western coastal zone, where it has a maximum concentration at Station 6573 (16,000 cells per litre) and in the stations to the south east. Otherwise it is scattered and occurs in small numbers. As regards occurrence this species resembles *Melosira sulcata*.

*Thalassiosira bioculata* (GRUN.) OSTF. A casual occurrence of this northern species was recorded at Station 6593.

*T. bioculata* var. *rariporta* GAARDER. This variety which has been described on the basis of the North Sea material from May, 1948 (GAARDER, 1952) was observed as an isolated occurrence at Stations 6483 and 6551, *i. e.* in the same locality (see Fig. 1) in both periods of collection. It was found here with rather regular vertical distribution. The numbers of individuals ranged between 3,500 and 6,500 per litre. In contradistinction to the other diatoms this variety did not show a decline in number during the period of investigation.

*T. decipiens* (GRUN.) JÖRGENS. It has not proved possible in the course of the quantitative analysis to determine with certainty all the individuals referred to this species. They are most frequent in the southern coastal stations, where their maximum at Station 6505 amounted to 75,000 individuals per litre. On the Dogger Bank the species locally attains considerable frequency. Otherwise it occurs only in small number.

*T. gravida* CL. has its most numerous occurrence in the western part of the Dogger Bank area, with 44,800 cells per litre as the maximum figure. Its distribution over our entire area will appear from Fig. 15.

*T. Nordenskjöldi* CL. The distribution of this species coincides with that of the foregoing, but the frequency is somewhat less. Also it has a stronger concentration in the western part of the Dogger Bank area.

*Thalassiothrix longissima* CL. & GRUN. A few, casual occurrences of this northern, oceanic species were recorded.

*Triceratium alternans* BAIL. A few individuals of this littoral species were found in the southern part of the area.

Pennate bottom diatoms. As regards this biological group of diatoms it has been impossible to carry out a determination of the species to the full extent with the methods used. Among species which have been determined in the sedimentation preparations may be mentioned: *Campylosira cymbelliformis*, *Cocconeis scutellum*, *Cymatosira belgica*, *Grammatophora marina*, *Navicula distans*, *Pleurosigma aestuarii*, *P. angulatum*, *P. fasciola*, *Rhaphoneis amphiceros*, *R. surirella*; of these *Navicula distans* is the species most frequently found in the plankton samples. Otherwise the occurrence of these littoral species in the free water masses is rather casual in character and they are frequently found in the form of empty cells or isolated valves. Very dense occurrences may be found along the coasts (GRÖNTVED, 1949), but even in deeper water — abt. 50 m. — an autochthonic vegetation rich in species of pennate bottom diatoms has been ascertained (BROCKMANN, 1937). In our investigations this group had its greatest concentration in the plankton samples from Section S. The general reduction in the stock of diatoms which took place during the period between the first and second collection applied to some extent also to the bottom diatoms as will be seen from the following table giving the average numbers of bottom diatoms per litre, calculated on the basis of all samples from Section R.:

|                        |       |       |       |                   |
|------------------------|-------|-------|-------|-------------------|
| Depth . . . . .        | 0 m.  | 10 m. | 20 m. | 50 m. (or bottom) |
| May 5th—6th, 47. . . . | 2,882 | 2,973 | 3,055 | 4,236             |
| — 19th—20th, 47. . . . | 250   | 550   | 1,400 | 2,520             |

In the homogeneous water masses (May 5th—6th) the figure is highest at the bottom, but otherwise the vertical distribution is rather regular. After the stabilization of the water the occurrences in the upper layers are relatively small.

## b. Dinoflagellates.

*Amphidinium sphenoides* WULFF. A few individuals of this species were observed at Station 6573.

Of the genus *Ceratium* the following species were found: *C. furca* (EHRB.) CLAP. & LACHM., *C. fusus* (EHRB.) DUJARDIN, *C. lineatum* (EHRB.) CL., *C. longipes* (BAIL.) GRAN, *C. macroceros* (EHRB.) CL., *C. tripos* (O. F. MÖLLER) NITZSCH, all with small frequency figures which, however, increased in the course of the period of investigation. At Station 6547 all species were represented, particularly *C. tripos* with relatively high numbers. Otherwise the occurrences were rather evenly distributed throughout the area.

The *Dinophysis* species have their greatest frequency in the eastern part of the area and show increasing frequency during the period of investigation, although there was not as yet any actual flowering. *D. norvegica* CLAP. & LACHM. were richest in number. Besides *D. acuminata* CLAP. & LACHM. and *D. acuta* EHRB. were represented.

*Exuviaella baltica* LOHM. This species was rather numerous at Station 6528 in Section S. Here a mass of water has penetrated from the south and the flora possesses special characteristics. The species occurs besides in a few individuals at a couple of neighbouring stations, but otherwise only scattered and small occurrences were observed, all in the southward Atlantic current and the adjacent areas. In the course of our investigations we found nowhere an actual stock of this variety as was the case in May, 1948, when it was common all over the North Sea but with maximum frequency in the southward Atlantic current (BRAARUD *et al.* 1952).

*Glenodinium lenticula* f. *asymmetrica* (MANGIN) SCHILL. Scattered occurrences of small numbers of this species were recorded, most of them at the coastal stations.

*Goniaulax spinifera* (CLAP. & LACHM.) DIESING and *G. triacantha* JÖRGS. A few individuals of these species were observed at a few scattered stations.

*Gymnodinium Lohmanni* PAULS. The occurrence of this species was in the main limited to the north-eastern part of the area. It always shows small frequency numbers.

*G. simplex* (LOHM.) KOF. & SWEZY. A few individuals referred to this species were found at Station 6598.

In almost all stations individuals were found, which — as no certain determination was possible in the preserved material — were regarded as belonging to the family *Gymnodiniaceae* and counted at the same figure. The numbers of individuals at the different stations vary between 100 and 13,000 per litre and are on the whole greatest in the eastern part of the area.

*Massartia rotundata* (LOHM.) SCHILL. This species occurs in small numbers at Stations 6593 and 6603.

Of the genus *Peridinium* the following species were found: *P. brevipes* PAULS., *P. crassipes* KOF., *P. depressum* BAIL., *P. globulus* var. *ovatum* (POUCHET) SCHILL., *P. leonis* PAV., *P. minusculum* PAV., *P. pallidum* OSTF., *P. pellucidum* (BERGH) SCHÜTT, *P. pentagonum* GRAN, *P. piriforme* PAULS, *P. triquetrum* (EHRB.) LEBOUR. Of these species *P. trochoideum* is of greatest frequency. It had its most numerous occurrences in the eastern part of the area and showed an increasing concentration during the period of investigation (see Fig. 14). *P. globulus* var. *ovatum* was like *Exuviaella baltica* rather numerous at Station 6528. On the whole its has its most frequent occurrences in the south-eastern coastal area and is more scattered in the rest of the area. *P. brevipes*, *P. depressum*, *P. minusculum*, and *P. pallidum* showed scattered occurrences in small numbers throughout the area, whereas the other species mentioned occur but sparsely and sporadically.

*Phalacroma rotundatum* (CLAP. & LACHM.) KOF. & MICH. This species was found only in few localities, most of them on the Dogger Bank.

*Porella perforata* (GRAN) SCHILL. Finds of small numbers of this species were made at Stations 6560 and 6588.

*Protoceratium reticulatum* (CLAP. & LACHM.) BÜTSCHLI. Without being frequent at any place, this species occurs in greatest number in the eastern coastal zone.

*Pyrocystis lunula* SCHÜTT. A few individuals of this species were observed at Station 6525.

### c. Coccolithophorides.

Sporadic occurrences of small numbers were recorded as regards the following species: *Anthosphaera robusta* (LOHM.) KAMPTNER, *Coccolithus Huxleyi* (LOHM.) KAMPTNER and *Rhabdosphaera styliifer* LOHM.

### d. Other Flagellates, etc.

*Bodo marina* BRAARUD. This heterotrophic species is spread over the entire area and is only missing at a few stations. Generally it is of considerable frequency (maximum figure 12,000 cells per litre) and it showed increasing frequency during the period of investigation. In the stratified water, May 19th—22nd, it had, like most other flagellates, its strongest concentration above the discontinuity layer.

*Carteria* spp. *diversae*. As regards this group only a determination of genus has been made, but probably two species are represented. They are particularly frequent in the eastern zone (at Station 6603 the maximum figure is 127,000 cells per litre). The frequency increased rapidly in the course of the period of investigation.

*Dictyocha fibula* EHRB. A few individuals of this species were found at Station 6477.

*Diplosiga* sp. *ad interim*. The Choanoflagellate shown in the drawing in Fig. 18, defies detailed description as I have seen only the one individual. It is provisionally referred to the genus *Diplosiga*. It has two collars, the outer one funnel-shaped with a crosswise rib and the inner one cylindrical and entirely hyaline.

*Distephanus speculum* (EHRB.) HAECKEL. This species occurs always in small numbers but is spread over the entire area of investigation.

*Monosiga marina* sp. nov. The individuals of this protomonade have no lorica but are provided with one flagellum and one collar and must therefore be assigned to the family *Craspedomonadaceae*. As

only solitary individuals have been observed they are taken to be a new *Monosiga* species. It must, however, be pointed out that no opportunity has presented itself to observe live cells, and the description is therefore solely based on observations of preserved material. Despite this deficiency it seems certain, however, that the description does not fit any of the species of this genus so far known, most of which for the rest belong in fresh water.

**Diagnosis:** Solitary protomonade without lorica, with one collar and one flagellum. The body globular-claviform,  $6-11\ \mu \times 3.5-5.5\ \mu$ . The collar hyaline, greatly varying in shape; length  $3.5-5.5\ \mu$ . Flagellum 3—4 times as long as the cell body. Generally an antapical prolongation "stalk" was found. The nucleus is globular, with a large nucleolus. No stage of propagation was observed. Regional distribution: The North Sea, the Skager Rack, the Norwegian Sea, the Faroe-Rockall area, Davis Strait.

**Description:** The species shows great morphological variation (Fig. 19). The shape of the body varies from globular to clavated form. The most general shape is that of an inverted oviform with a more or less tapered base. At the apex a hyaline, structureless collar of varying form is to be found, cylindrical, funnel-shaped, bowl-shaped, vasiform, or jar-shaped. It is a wellknown fact (see, e. g. BÜTSCHLI 1883—1887; BURCK 1909; VALKANOV 1926, and RUINEN 1938), that the cell body of the *Craspedomonadaceae* possesses great power of contraction, so that it may suddenly contract into globular shape, and the collar is likewise an organ highly capable of changing its shape. The variation in shape shown in Fig. 19, which, however, does not give the full extent of the morphological variation, is intended as an example to illustrate the width of variation, it must largely be taken to express that the body of the cell and the collar in the preparation have been fixed at different stages of contraction.

Most individuals have "stalks" of different lengths, some are, however, "stalkless". Only free living individuals were observed, and the "stalk" may not serve as an organ of attachment, for which purpose, by the way, it seems rather unsuitable as it always tapers off towards its free end and often is finely pointed. The flagellum is 3—4 times as long as the body of the cell and protrudes from it at the centre of the collar.

The nucleus is globular and contains a relatively large nucleolus, it lies in the front part of the cell at a short distance from the base of the flagellum. In some cases a vacuole was observed in the basal part. The plasma in some cases contained grains with greater power of refraction.

No stages of propagation were observed.

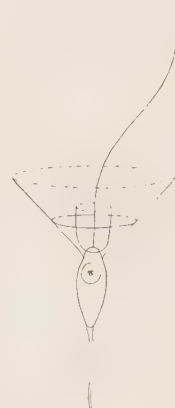


Fig. 18. *Diplosiga* sp. *ad interim*. From Station 6495 — 10 m. ( $\times 1110$ ).

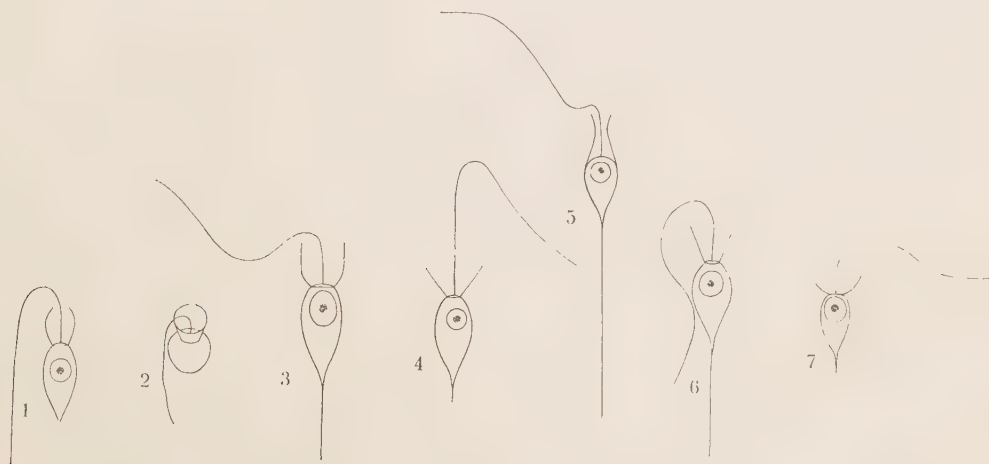


Fig. 19. *Monosiga marina* sp. nov. A number of individuals show the morphological variation observed in the preserved material. The distal limitation of the hyaline collar could not be seen in the case of the individuals being viewed from the side, and in their case the collar is therefore shown in optical section. In No. 2 which was seen obliquely from above all outer contours can be seen. ( $\times 1110$ ).

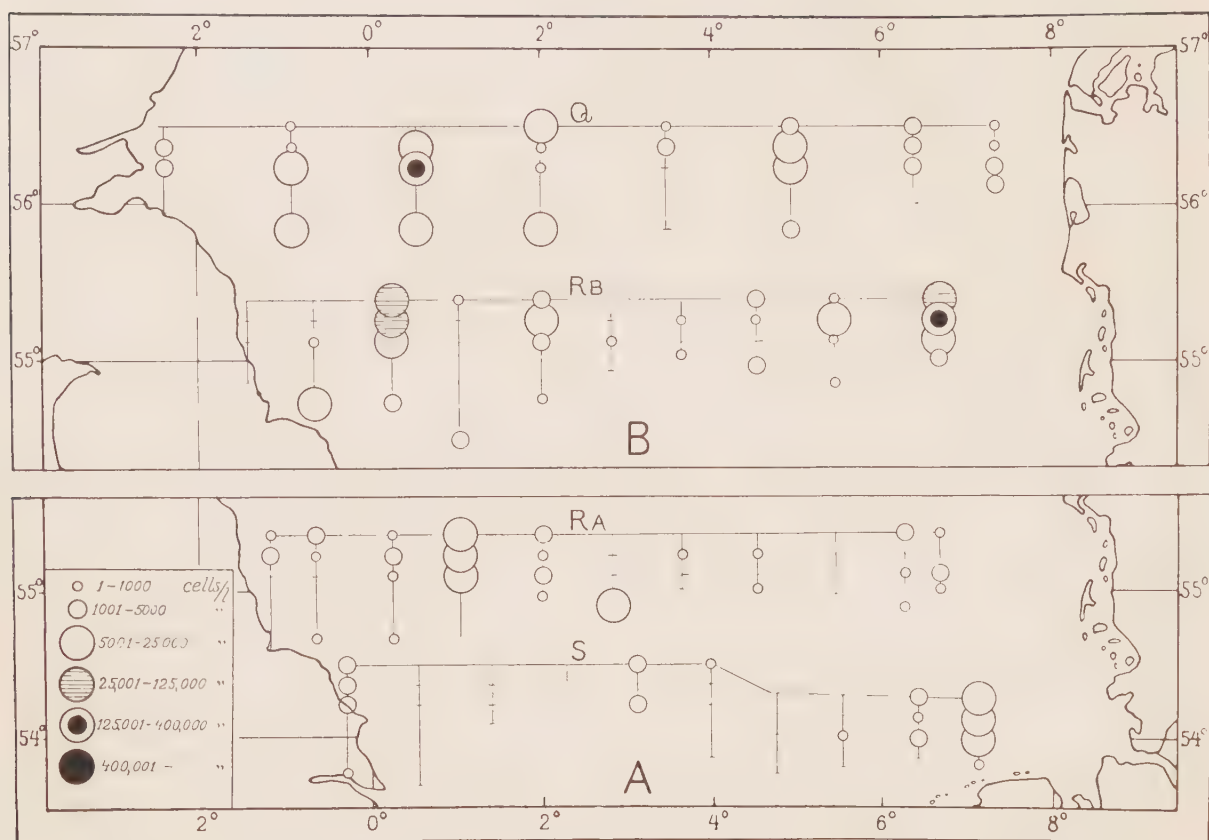


Fig. 20. Distribution of *Monosiga marina* in the southern North Sea in May, 1947. A: May 5th–8th; B: May 19th–22nd. The species thrives in all the types of water found here. It showed an increasing tendency during the period of investigation.

Dimensions: Body:  $6-11 \times 3.5-5.5 \mu$ .

Length of collar:  $3.5-5.5 \mu$ .

The occurrence of *Monosiga marina* in our samples will appear from Fig. 20. In 1948 the species was of similar occurrence in this area and was otherwise found in the Skagër Rack, the northern part of the North Sea, the Norwegian Sea, and the Faroe-Shetland Channel (BRAARUD *et al.* 1952), further, the author of this treatise has observed it in the Faroe-Rockall area and in the waters west of Greenland. It is thus spread over a wide region, although it is most numerous in the southern part of the North Sea. The fact that it occurs in highly different water masses indicates that it possesses great ecological amplitude.

*Phaeocystis* sp. The *Phaeocystis* occurring in the southern part of the North Sea has generally been assigned to the species *globosa* SCHERFFEL, and it is possible that all our finds should be referred to this species. It has not, however, been possible to make a definite determination of species in the formalin preserved material, and the question of species must therefore be left unanswered. The occurrence of *Phaeocystis* is reproduced in Fig. 17, which shows a rather even distribution, although not in great numbers during the first period of collection and denser concentrations in the eastern zone during the second collection. Such patches of *Phaeocystis* are known to form barriers for the herring in its migrations (SAVAGE 1930; SAVAGE and HARDY 1935; WULFF 1934).

*Pterosperma cristatum* SCHILL. This species occurs in scattered localities and in small numbers, most of the occurrences are in the southern part of the area.

*Trochiscia Clevei* LEMMERM. A few individuals of this species were observed at Station 6598.

*Trochiscia discoidea* *nom. nud.* This species was found in the southern North Sea in May, 1948 (BRAARUD *et al.* 1952) at the following positions:  $52^{\circ}52' \text{ N.}-3^{\circ}10' \text{ E.}$ ;  $54^{\circ}21' \text{ N.}-2^{\circ}58' \text{ E.}$ ;  $54^{\circ}28' \text{ N.}-0^{\circ}25'$

W.; 54°16' N.—7°29' E.; 55° 25' N.—4°24' E.; it was in no case of great frequency and was not observed in our material from 1947.

No detailed examination will be made of the systematics of this species, as it is obviously a fact that the genus *Trochiscia* within its limits so far, comprises organisms of widely different systematic origin (NORDLI 1951), wherefore the entire genus should be reviewed. Under such circumstances it will hardly be warranted to describe new *Trochiscia* species without having made observations of the material *in vivo*. The species in question is introduced here under a *nomen nudum*, reference being made to the drawing, Fig. 21. In this connection may only be mentioned that in contradistinction to previously known *Trochiscia* species it is not of spherical but of cylindrical shape and that the dimensions of the cell body are the following:

Long diameter: 12—14  $\mu$ ;  
Short diameter: 8  $\mu$ .

Not classified flagellates and monades. The individuals assigned to this group could not be classified in the preserved material. They are all small organisms, the majority are spherical in shape; cilia could not in all cases be distinguished. The groups was very numerous represented during the latter collection, May 19th—22nd.

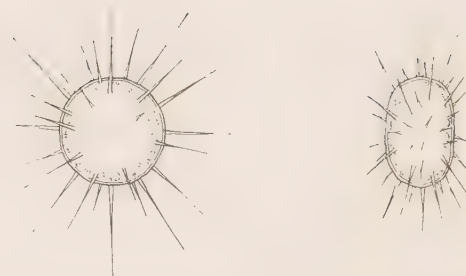


Fig. 21. *Trochiscia discoidea* nom. nud. Both figures show the same individual in front view and in side view. (From collection 1948 (BRAARUD *et al.* 1952); Station S<sub>1</sub> — 20 m.). ( $\times 1150$ ).

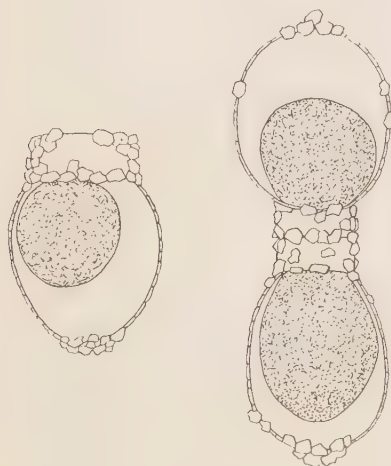


Fig. 22. *Codonellopsis lagenula*? Solitary and conjugating. (From collection 1948 (BRAARUD *et al.* 1952); Station R<sub>15</sub> — 20 m.). ( $\times 1110$ ).

#### e. Ciliates.

In our material the ciliates are represented by the following species: *Codonellopsis lagenula* (CLAP. & LACHM.) JÖRGENS., *Dinidium parvulum* GAARDER, *Laboea conica* LOHM., *L. constricta* LEEG., *L. crassula* LEEG., *L. emergens* LEEG., *L. strobila* LOHM., *L. vestita* LEEG., *Lohmanniella oviformis* LEEG., *Mesodinium rubrum* LOHM., *Metacyclis mediterranea* (MERESCHKOWSKY) JÖRGENS., *Ptychocylis urnula* (CLAP. & LACHM.) BRANDT, *Strombidium acutum* LEEG., *Tintinnopsis beroidea* STEIN emend. ENTZ. SR. emend. JÖRGENS., *Woodania conicoides* LEEG. Of these *Lohmanniella oviformis* is of most frequent occurrence, *Laboea conica*, *L. vestita* and *Mesodinium rubrum* are rather numerous, and the remainder more or less rare.

The ciliate shown in Fig. 22 has with some hesitation been assigned to the species *Codonellopsis lagenula*, as I could not observe the annulation of the collar and its length (abt. 20  $\mu$ ) was materially smaller than usually stated in respect of this species. In one sample (1948: R<sub>15</sub> — 20 m.) almost all individuals were in conjugation. In 1947 this species was found only at Station 6603. In the 1948-material it was recorded at stations T<sub>4</sub>, U<sub>4</sub>, R<sub>9</sub>, and R<sub>15</sub>. (Cf. BRAARUD *et al.* 1952).

### 6. Oil pollution caused by *Coscinodiscus concinnus*.

In the North Sea *Coscinodiscus concinnus* has its densest and most constant occurrence in the south-eastern part. The maximum is usually reached in the first half of the year (CLEVE 1897; Bulletin des Résultats etc., Années 1902—1908; OSTENFELD 1913; GRAN 1915; SAVAGE & WIMPENNY 1936; WIMPENNY 1949).

In the western part of the North Sea rather dense concentrations have on several occasions been observed in patches particularly west and south of the Dogger Bank. Otherwise it occurs

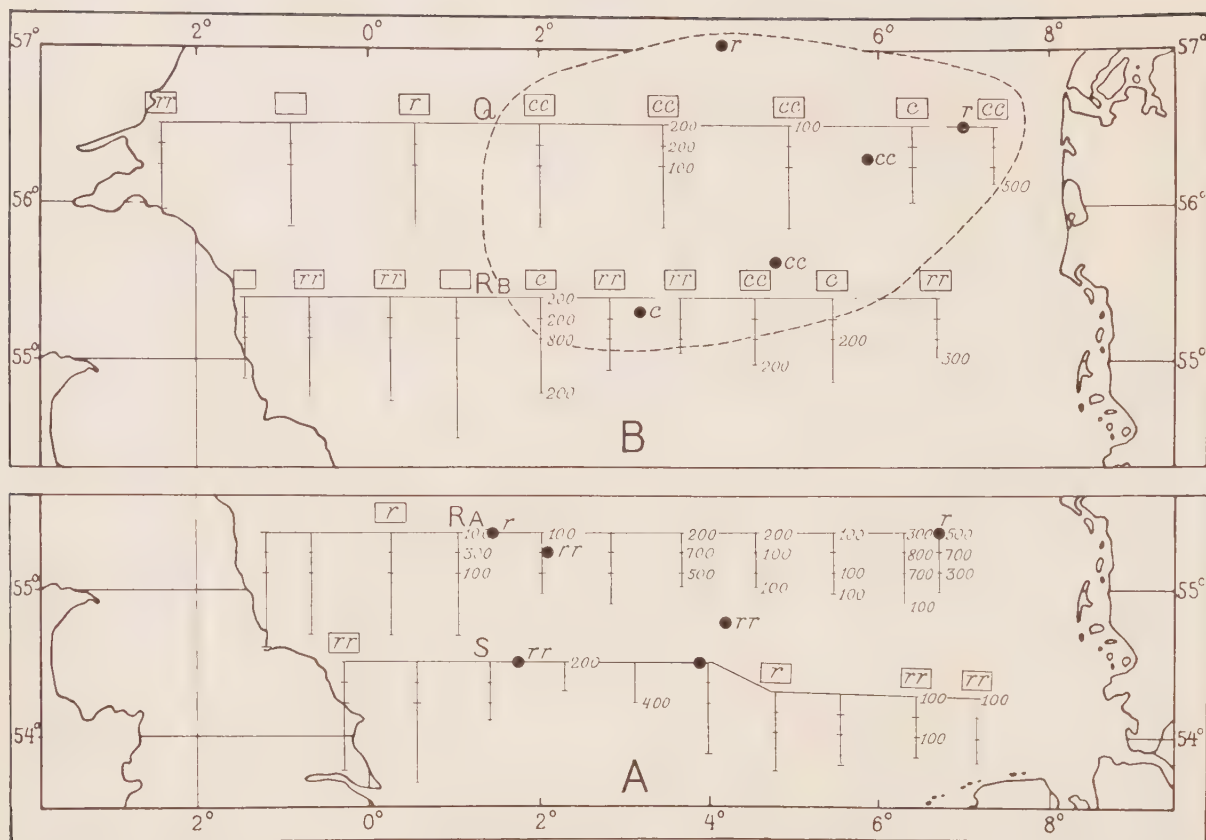


Fig. 23. Chart of the occurrences of *Coscinodiscus concinnus* in May, 1947. S—R<sub>A</sub>: May 5th—8th; R<sub>B</sub>—Q: May 19th—22nd. The stations outside the sections were under A taken on May 13th—16th and under B on May 17th—29th. In sections Q, R and S water samples were taken for plankton examination in the surface and at the depths indicated by the vertical lines (scale: 2.7 mm. = 10 m.). The frequency figures for *C. concinnus* are given as number of individuals per litre and placed at the depths from which they originate. □ immediately above the plankton stations indicates that at these places plankton samples have been taken in the surface with a net of silk-gauze No. 25, and the letters inserted in the square are the frequency symbols commonly used in connection with estimates: (cc = very common; c = common; + = rather common; r = rare; rr = very rare). An empty square indicates that the species was not found in the sample. A black circle with letters indicates that at this place a net sample was taken at the surface but no water samples. The letters inserted indicate degrees of frequency. When such letters are missing, the species has not been observed. Inside the area marked with a stippled line an oil film was observed on the surface of the sea and in the sample bottles in which on account of the stronger concentration the phenomenon is particularly pronounced. The conformity of the *C. concinnus* occurrences and the extension of the oil film is very good.

The low concentration of *C. concinnus* in the south-easterly station (Fig. 23 B) is particularly conspicuous as the species was frequent at this place during the first period of investigation (Fig. 23 A). This may be explained by the fact that a renewal of the water has taken place (cf. p. 10).

At the departure from the northernmost station (lat. 57°03' N.) on May 29th, 1947, the ship was on a north-westerly course and soon left the oil field. Judging from the general distribution of *C. concinnus* and from current conditions within the area the oil field has probably extended farther in the north-easterly direction than shown in Fig. 23 B, but we had no opportunity to make further investigations in this respect.

sporadically in the plankton throughout the North Sea at all seasons, a circumstance which is connected with the fact that the species has no morphologically differentiated resting stage but is holoplanktonic. It must be considered autochthonous throughout the North Sea area.

In the part of the North Sea marked in Fig. 23 B, where the "DANA" made her investi-

gations on May 17th—29th, 1947, the surface of the sea was covered by an oleaginous film the lower limit of which, however, was rather diffuse. It was of greyish-white colour and without the interference colours frequently seen on films of mineral oils. It was not observed when we passed this area on May 5th—6th, but was now very conspicuous (Fig. 24). The phenomenon has been described by TÅNING (1951).

The microscopic examination of net samples from the surface in this polluted area proved that the film consisted of oil in which various plankton organisms with *C. concinnus*



Fig. 24. The oil film photographed from the "DANA". The ship's wake forms a deep-blue stripe across the pale, oily sea (from TÅNING, 1951).

as the predominant species were in suspension. The quantitative occurrence of this species in the samples closely coincides with our observations from the ship of the oil film at the localities in question, and no other plankton species or groups of species were present in these samples in sufficient number or with sufficient regularity to make it possible to consider their presence a cause of the film formation. *C. concinnus* is, indeed, by TÅNING (l. c.) considered the cause of the film after by saponification it had been proved that the oil was of biological origin.

The micro-photographs (Pl. I, Fig. 4) show the main components of the surface film: oleaginous *C. concinnus* cells and free oil which must have seeped from these cells (Pl. I, Fig. 3). In this connection it may be observed that *C. concinnus* — at any rate periodically — has a very large fat content. Thus, in May, 1948, a *C. concinnus* patch was found west of the Dogger Bank in an area, where vertical plankton hauls were made with HENSEN net, and a considerably higher fat content (30—40 %) was found in the plankton from this patch than at the surrounding stations. The increase must be due to *C. concinnus* (WIMPENNY 1949). An analysis of one of our surface net samples in 1947 showed 37.5 pCt. of ether-extractable fat in the dry matter (TÅNING l. c.). Of plankters this sample practically contained only *C. concinnus*, the cells of which were surrounded by free oil.

How is this film formed? In other words, what are the reasons why *C. concinnus* floats on the surface? It really must be considered probable that living, vegetative, planktonic

diatom cells under optimal conditions will have the same specific gravity as seawater (GROSS & ZEUTHEN 1948) and will stay at their level or be carried slowly up- and downwards with the convection currents, and that dead and sporiform diatom cells generally are of greater specific gravity than water and therefore will sink.

It has been mentioned above that the formation of film was not observed at the beginning of May, but Fig. 23 A shows that *C. concinnus* then had a slightly greater frequency in the lower layers of the water masses than in the latter part of May, at which time it was, on the other hand, more frequent in the net samples from the surface. Thus, material parts of the stock have in the meantime been carried to the surface. Now, during the same period the water has to some extent become thermically stratified (Fig. 3) and the cells cannot therefore have been carried upwards by vertical currents. The cause of the buoyancy must be ascribed to reduced specific gravity due to increased oil content.

Apparently living conditions are not optimal in these water masses. By the stratification changes have occurred which have entailed a stoppage of reproduction, but which are without material influence on the course of the photosynthesis. Under these circumstances in which the assimilated substances are not used in reproduction, they accumulate as oil in the cells and the specific gravity of the latter will decline.

If we are looking for a cause of the stoppage of the propagation process we will easily be led to think of the content of nutrients in the water, and particularly of phosphates and nitrates. In a shallow area like the southern part of the North Sea these substances are presents in their largest quantities immediately above the sea-bottom where they are formed by the decomposition of organic substances. Thence they may be carried to the upper strata by vertical currents, but in stratified water masses there is only little chance of such vertical transportation and the nutrients in the upper strata will gradually become exhausted.

To be true, the quantities of phosphate and nitrate were at no time large during our investigations (Tables 1—21), but there is the material difference between conditions at the beginning of May and those obtaining at the end of that month, that in the former period the possibilities of renewed supplies of nutrients to the upper strata gradually as those present became exhausted, were less than in the latter period when we have "old water" in the surface.

It seems probable that such a difference in the content of nutrients in the water will entail disastrous results for a species like *C. concinnus*, which on account of the large size of cell must be presumed to require a stronger concentration of nutrients than species of similar shape but of a size, say 100 times less of cell surface, or for instance, of the genus *Chaetoceros* the shape of cell of which is particularly favourable to the absorption of dissolved nutrients.

The possibility remains that a lack of nutrients other than those mentioned may have caused or contributed to the stoppage of reproduction of *C. concinnus*, and finally, we cannot disregard the fact that the higher temperature which caused stratification may have had a direct influence of this stoppage, inasmuch as judging from its most common occurrences *C. concinnus* is a cold-water species. Its autecology has not, however, been sufficiently examined and any further discussion of the cause of the change in physiology of the species under the circumstances described must be abandoned, as this problem was not a direct aim of our investigations.

A *C. concinnus* surface occurrence like that found in 1947 was observed in the north-eastern part of the Dogger Bank area in May, 1933 (SAVAGE & WIMPENNY 1936). Also at that time the water masses were thermically stratified (BULLETIN HYDROGRAPHIQUE, 1934). A dense concentration of *C. concinnus* was found in May, 1904 throughout the eastern part of the North

Sea from 54° to 59° N. (BULLETIN DES RÉSULTATS ETC., ANNÉE 1903—1904, 1904). The species was numerous represented at all stations examined, it was, however, missing in some of the surface samples and in the other samples it was less frequent than in the corresponding vertical hauls. From this investigation no information is given as regards observations of surface mass occurrences of *C. concinnus*. Otherwise conditions closely resembled those obtaining during our investigation at the beginning of May, 1947, also insofar as the water masses were homogeneous — except in the area of the Norwegian coastal current — and the opinion set forth in the foregoing that the living conditions causing the formation of *C. concinnus* slicks are interconnected with the stratification of the water is thus confirmed by the two investigations mentioned.

Actually there is nothing curious in the fact that the eastern part of the North Sea according to the above must be considered the proper place for *C. concinnus* slicks, as the species has its greatest frequency in this particular area. It may, however, be considered amazing that the phenomenon occurred in 1947, when the concentration of the species was rather slight (Fig. 23). *C. concinnus* is numerically richest represented in the samples from the eastern part of Section R<sub>A</sub>, and although the absolute numbers are small here too, the total population will be sufficiently numerous to form a surface film of considerable extent and thickness. If we regard, for instance Station 6477 (see Chart, Fig. 1), the frequencies there are 300, 800, 700, and 100 cells per litre at 0, 10, 20, and 35 m., respectively. A simple calculation shows that if all these cells are carried to the surface, the number there will be 1,940 per sq. centimetre, and if 300  $\mu$  is taken as the average diameter of the valve, it will be found that the said number will be more than adequate to form a film of the thickness of one cell. The *C. concinnus* cells must be presumed to be rising gradually so that the film will be reinforced successively by supplies from below. Further, it is a known fact (EWING 1950) that horizontally converging currents will cause an accumulation of oil film, and as such converging currents actually exist in the area under review (Fig. 2), that area must offer particular conditions for the formation of a heavy film, the more so as the current arrows indicate the possibility of reinforcement by supplies of *C. concinnus* cells from extensive parts of the rest of the North Sea.

Natural slicks seem to constitute a rather common phenomenon on the surface of the sea, particularly in coastal waters. They must be considered to originate principally from phytoplankton and particularly from diatoms (DIETZ & LAFOND 1950), but otherwise these phenomena have not so far been subjected to detailed investigation as regards original causes, periods of occurrence or regional distribution. On the other hand, artificial slicks, caused by oil pumped out by ships or industrial undertakings ashore which use the sea as a receptacle for oleaginous waste products, and their disastrous consequences have often been mentioned. Particularly the disasters to great numbers of sea-birds are well known. By various measures many countries have endeavoured to prevent such pollution within their territorial waters. It must be considered probable that natural slicks cover greater areas than the artificial ones (DIETZ & LAFOND l. c.; EWING 1950) and their detrimental effects — the death of birds, plankton animals and pelagic fish spawn, which come into direct contact with the oil, and also the obscuration of submarine light to the detriment of photosynthetic activity — are possibly great, even if the vegetable oil will be decomposed in a relatively short time.

## 7. English Summary.

An examination has been made of the phytoplankton in the southern part of the North Sea in the area between lats  $54^{\circ}$  and  $57^{\circ}$  N., through samples collected by the Danish research vessel "DANA", which on May 5th to 8th and 19th—22nd, 1947, undertook investigations in this area (Fig. 1) in connection with a hydrographic investigation made at the instance of THE INTERNATIONAL COUNCIL FOR THE EXPLORATION OF THE SEA and comprising the whole of the North Sea and the adjoining waters.

The plankton stock was numerically greatest in the coastal zones and in the Atlantic current, less numerous on the Dogger Bank and in the area north of the bank (see Fig. 8). In the British coastal zone *Asterionella japonica* and *Skeletonema costatum* predominate and *Chaetoceros* species are numerous. The southward Atlantic current shows a considerable density of *Chaetoceros compressus*, *C. debilis* and *C. subsecundus*, and also of *Monosiga marina* and other flagellates.

In the south-eastern area which is situated about the 40 metre curve and thus does not reach the coast the stock of plankton is less than in the western part and more heterogeneous. *Chaetoceros danicus*, *Melosira sulcata*, *Rhizosolenia imbricata* var. *Shrubsolei*, *Peridinium globulus* var. *ovatum* are rather wide-spread in the southern part, *Chaetoceros debilis*, *Coscinodiscus concinnus*, *Peridinium trochoideum* and *Monosiga marina* in the eastern part. Common to both sectors are *Chaetoceros affinis*, *Nitzschia closterium*, *N. delicatissima*, *Phaeocystis* and the typical coastal species *Biddulphia aurita* and *B. rhombus*.

In the Dogger Bank area patches of *Thalassiosira gravida*, *T. Nordenskjoeldi*, *T. bioculata* var. *raripora* and *Leptocylindrus minimus* were observed. Widely spread but in small concentration were *Coscinodiscus concinnus*, *Melosira sulcata*, *Bodo marina* and *Monosiga marina*.

In the area north of Dogger a peculiar surface occurrence of *Coscinodiscus concinnus* was found (see below), but otherwise diatoms were very few. Dinoflagellates and other flagellate groups were somewhat more numerous.

During the first part of the period of collection diatoms constituted the predominant constituent of the plankton. During the latter collection this group had decreased very heavily, whereas the flagellate groups recorded some numerical advance. This succession is a common phenomenon in the spring and occurs simultaneously with or immediately after a certain stabilization of the water due to heating. Thereby turbulent movements are prevented and nutrition conditions for the plankton diminished. The consumption by plankton animals is taken to be a contributory cause of the reduction in the stock of diatoms. Due to the low temperature during the winter and spring of 1947 the succession that year took place somewhat later than in 1948 (see Chapter 4).

At the close of the period of investigation a kind of oil pollution was observed over an extensive area in the north-eastern part, due to *Coscinodiscus concinnus* (Fig. 23; Pl. I). The phenomenon must obviously be explained as follows: When turbulent activity is prevented due to the stabilization of the water a shortage of supplies necessary for the reproduction of this species will occur, while the photosynthesis will not be affected. This activity will therefore continue and the assimilates will accumulate in the cell in the form of oil. Thereby the specific gravity will be reduced so much that it will become less than that of the water, and the cell will rise to the surface where the oil will gradually seep out (see Pl. I) and form a surface film consisting of free oil, *C. concinnus* cells in dense concentration and a small but varying number of other plankton organisms, the presence of which cannot be related to the formation of the

film, on the contrary it is, at any rate partly a consequence thereof. A natural oil pollution will involve the same disadvantages — particularly the mass killing of birds is wellknown — as the artificial pollution caused by waste oil, a commonly known phenomenon, the detrimental effects are, however, limited, the vegetable oil being decomposed in a relatively short time.

## 8. Dansk oversigt.

Phytoplanktonet, d. v. s. vegetationen i de frie vandmasser, er undersøgt i den sydlige Nordsø mellem 54—57° n. br. gennem prøver indsamlet af havundersøgelsesskibet "DANA" <sup>5 8/5</sup> og <sup>19-22/5</sup> 1947 (se fig. 1). Planktonbestanden var talrigst i kystzonerne og i den sydgaaende atlantiske strøm, mindre paa Dogger Bank og i omraadet nord for (se fig. 8). I periodens første del var diatoméerne det helt overvejende element i planktonet; under den sidste indsamling var denne gruppe aftaget meget stærkt, mens forskellige flagellatgrupper viste tiltagende individantal. En saadan skiften fra en vegetationstype til en anden er et almindeligt fænomen om foraaet, naar vandet som følge af opvarmning er bleven lagdelt, d. v. s. har tiltagende vægtfylde nedefter; under saadanne omstændigheder er ernæringsmulighederne for planktonet forringede, idet der ikke føres næringsrigt dybdevand op til de øvre lag med vertikale strømninger; som en væsentlig aarsag til reduktionen af diatoméebestanden opfattes her tillige afgræsning af disse organismer ved planktondyr. Som følge af den lave temperatur i vinter og foraar 1947 er denne vegetationsskiften dette aar foregaaet senere end i 1948 (se kap. 4).

I slutningen af undersøgelsesperioden iagttoges over et vidtstrakt omraade i den nordøstlige del olieforurening frembragt af en diatomée: *Coscinodiscus concinnus* (fig. 23; Pl. I), der under de paa dette tidspunkt eksisterende hydrografiske forhold — og her skal navnlig vandets lagdeling fremhæves — ophobede store mængder oplagsnæring i form af olie i cellen; derved reduceres vægtfylden saa stærkt, at den bliver mindre end vandets og cellen stiger op til overfladen; her vil olieindholdet efterhaanden sive ud (se Pl. I) og en overfladisk hinde dannes bestaaende af fri olie, *C. concinnus*-celler i tæt koncentration og et mindre — og vekslende — antal af andre planktonorganismer, hvis tilstedeværelse ikke kan sættes i aarsagsforbindelse med hindedannelsen; den er tværtimod, i hvert fald til dels, en følge af denne. En naturlig olieforurening som den beskrevne medfører de samme ulemper — navnlig massedød af fugle er velkendt — som den kunstige, der foraarsages af udtømt spildolie, skadevirkningerne begrænses dog derved, at den vegetabiliske olie relativt hurtigt nedbrydes.

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Table 1.

St. 6503, Sect. R. Lat.: 55°23' N., Long.: 1°15' W.  
Plankton per litre. 6/5-47.

| Depth in metres                       | 0      | 10     | 20     | 56     |
|---------------------------------------|--------|--------|--------|--------|
| Temperature, °C                       | 5.51   | 5.50   | 5.42   | 5.26   |
| Salinity, per mille                   | 34.38  | 34.38  | 34.45  | 34.51  |
| $\sigma_t$                            | 27.15  | 27.15  | 27.21  | 27.28  |
| P, $\mu\text{g-atom/L}$               | ..     | ..     | ..     | ..     |
| $\text{NNO}_3$ , $\mu\text{g-atom/L}$ | 5.5    | ..     | 8.0    | 8.0    |
| $\text{O}_2$ , ml/L                   | 6.98   | ..     | ..     | 6.96   |
| $\text{O}_2$ , % of saturation        | 100.0  | ..     | ..     | 99.3   |
| Number of ml examined                 | 2 & 10 | 2 & 10 | 2 & 10 | 2 & 10 |

## Diatoms:

|                                    |       |        |        |         |
|------------------------------------|-------|--------|--------|---------|
| <i>Actinoptychus undulatus</i>     | ..    | 100    | 200    | 100     |
| <i>Asterionella Bleakeleyi</i>     | ..    | ..     | 37,000 | ..      |
| — <i>japonica</i>                  | 6,300 | 6,500  | 6,100  | 24,700  |
| <i>Bacteriastrium hyalinum</i>     | ..    | 100    | ..     | ..      |
| <i>Chaetoceros cinctus</i>         | 300   | 100    | 200    | 7,100   |
| — <i>compressus</i>                | 1,200 | 800    | 1,600  | 25,900  |
| — <i>debilis</i>                   | ..    | 600    | ..     | 600     |
| — <i>decipiens</i>                 | ..    | 300    | ..     | 300     |
| — <i>gracilis?</i>                 | ..    | ..     | ..     | 100     |
| — <i>laciniosus</i>                | ..    | 400    | ..     | ..      |
| — <i>subsecundus</i>               | 200   | 300    | ..     | 400     |
| — <i>teres</i>                     | ..    | ..     | ..     | 200     |
| — <i>sp.</i>                       | 200   | 100    | 1,200  | 600     |
| <i>Ditylum Brightwelli</i>         | 100   | ..     | ..     | 300     |
| <i>Leptocylindrus danicus</i>      | ..    | ..     | ..     | 300     |
| <i>Melosira sulcata</i>            | 2,200 | 1,400  | 1,800  | 9,500   |
| <i>Nitzschia closterium</i>        | 2,100 | 3,500  | 2,300  | 1,800   |
| — <i>delicatissima</i>             | 900   | 2,400  | 1,100  | 10,000  |
| — <i>seriata</i>                   | ..    | 400    | 100    | 100     |
| <i>Pleurosigma aestuarii</i>       | 100   | 100    | ..     | 100     |
| <i>Podosira stelliger</i>          | ..    | 200    | ..     | ..      |
| <i>Rhizosolenia alata</i>          | ..    | ..     | 100    | ..      |
| <i>Skeletonema costatum</i>        | 3,200 | 15,600 | 23,400 | 643,000 |
| <i>Thalassionema nitzschioides</i> | 1,600 | 2,900  | 1,100  | 4,700   |
| <i>Thalassiosira Nordenskjöldi</i> | 100   | 200    | 300    | ..      |
| — <i>decipiens</i>                 | 500   | 600    | 1,700  | 5,100   |
| Pennate bottom diatoms             | 5,000 | 7,000  | 7,500  | 16,500  |

## Dinoflagellates:

|                              |       |       |     |     |
|------------------------------|-------|-------|-----|-----|
| <i>Glenodinium lenticula</i> |       |       |     |     |
| f. <i>asymmetrica</i>        | ..    | 100   | ..  | ..  |
| <i>Gymnodinium</i>           | 1,000 | 2,000 | 500 | ..  |
| <i>Peridinium depressum</i>  | ..    | 100   | ..  | ..  |
| <i>Peridinium minusculum</i> | 100   | ..    | ..  | ..  |
| — <i>trochoideum</i>         | 100   | 100   | 100 | 200 |

## Other flagellates, etc.:

|                             |     |       |       |       |
|-----------------------------|-----|-------|-------|-------|
| <i>Bodo marina</i>          | 600 | 100   | 1,000 | 1,500 |
| <i>Distephanus speculum</i> | ..  | ..    | ..    | 200   |
| <i>Monosiga marina</i>      | 500 | 2,000 | ..    | ..    |
| <i>Phaeocystis sp.</i>      | rr  | ..    | ..    | ..    |

Table 1 (continued).

| Depth in metres                        | 0     | 10    | 20    | 56  |
|----------------------------------------|-------|-------|-------|-----|
| Monades and flagellates not classified | 3,000 | 3,000 | 1,500 | 500 |
| Ciliates:                              |       |       |       |     |
| <i>Laboea vestita</i>                  | ..    | 100   | 200   | ..  |
| <i>Lohmanniella oviformis</i>          | ..    | ..    | ..    | 200 |
| <i>Mesodinium rubrum</i>               | ..    | 300   | 100   | ..  |

Table 2.

St. 6498, Sect. R. Lat.: 55°23' N., Long.: 0°14' E.  
Plankton per litre. 6/5-47.

| Depth in metres                       | 0      | 10     | 20     | 50     |
|---------------------------------------|--------|--------|--------|--------|
| Temperature, °C                       | 4.85   | 4.76   | 4.64   | 4.20   |
| Salinity, per mille                   | 34.71  | 34.71  | 34.71  | 34.75  |
| $\sigma_t$                            | 27.48  | 27.49  | 27.50  | 27.58  |
| P, $\mu\text{g-atom/L}$               | 0.1    | ..     | 0.05   | ..     |
| $\text{NNO}_3$ , $\mu\text{g-atom/L}$ | 2.0    | ..     | 2.0    | ..     |
| $\text{O}_2$ , ml/L                   | 7.27   | ..     | ..     | ..     |
| $\text{O}_2$ , % of saturation        | 102.6  | ..     | ..     | ..     |
| Number of ml examined                 | 2 & 10 | 2 & 10 | 2 & 10 | 2 & 10 |

## Diatoms:

|                                                   |        |        |        |        |
|---------------------------------------------------|--------|--------|--------|--------|
| <i>Asterionella japonica</i>                      | ..     | 1,100  | ..     | 4,500  |
| <i>Cerataulina Bergoni</i>                        | 100    | ..     | 600    | ..     |
| <i>Chaetoceros affinis</i>                        | ..     | ..     | ..     | 300    |
| — <i>ceratosporum?</i>                            | ..     | 100    | 200    | 300    |
| — <i>cinctus</i>                                  | 1,100  | 2,500  | 9,100  | 31,800 |
| — <i>compressus</i>                               | 26,500 | 16,400 | 26,100 | 98,500 |
| — <i>debilis</i>                                  | ..     | ..     | ..     | 1,700  |
| — <i>decipiens</i>                                | ..     | ..     | 800    | 1,900  |
| — <i>densus</i>                                   | 100    | ..     | ..     | 800    |
| — <i>laciniosus</i>                               | ..     | ..     | ..     | 200    |
| — <i>subsecundus</i>                              | 2,900  | 1,900  | 3,300  | 8,300  |
| — <i>sp.</i>                                      | ..     | ..     | 2,500  | 2,000  |
| <i>Coscinodiscus centralis</i>                    | ..     | ..     | ..     | 200    |
| <i>Hyalodiscus scoticus</i>                       | ..     | 100    | ..     | ..     |
| <i>Leptocylindrus danicus</i>                     | ..     | ..     | 900    | 700    |
| — <i>minimus</i>                                  | 300    | ..     | 600    | ..     |
| <i>Melosira sulcata</i>                           | 600    | 1,300  | ..     | 2,600  |
| <i>Nitzschia closterium</i>                       | 1,300  | 1,700  | 2,500  | 2,100  |
| — <i>delicatissima</i>                            | 2,500  | 2,000  | 8,000  | 21,000 |
| <i>Rhaphoneis surirella</i>                       | ..     | ..     | ..     | 500    |
| <i>Rhizosolenia hebetata</i> f. <i>semi-spina</i> | ..     | ..     | 200    | ..     |
| — <i>Stolterfothii</i>                            | 200    | 400    | ..     | ..     |
| <i>Skeletonema costatum</i>                       | 400    | 1,800  | 2,700  | 15,500 |
| <i>Thalassionema nitzschioides</i>                | 600    | ..     | 500    | 2,200  |
| <i>Thalassiosira gravida</i>                      | 900    | 1,100  | 1,500  | 2,100  |
| — <i>Nordenskjöldi</i>                            | ..     | ..     | 200    | 300    |
| Pennate bottom diatoms                            | 1,000  | ..     | 1,000  | 3,000  |

Table 2 (continued).

| Depth in metres                             | 0      | 10    | 20     | 50     |
|---------------------------------------------|--------|-------|--------|--------|
| <b>Dinoflagellates:</b>                     |        |       |        |        |
| <i>Dinophysis acuta</i> .....               | 100    | ..    | ..     | ..     |
| — <i>debilior</i> .....                     | ..     | ..    | 100    | ..     |
| <i>Gymnodinium</i> sp.....                  | 2,000  | 4,500 | 7,000  | 11,000 |
| <i>Peridinium depressum</i> .....           | 300    | 100   | 400    | ..     |
| — <i>globulus</i> var. <i>ovatum</i> ..     | ..     | 100   | ..     | ..     |
| — <i>leonis</i> .....                       | ..     | ..    | 100    | ..     |
| — <i>minusculum</i> .....                   | ..     | ..    | 100    | ..     |
| — <i>pallidum</i> .....                     | 100    | ..    | ..     | ..     |
| — <i>trochoideum</i> .....                  | 200    | 400   | ..     | 100    |
| <i>Protoceratium reticulatum</i> ..         | 100    | 200   | 200    | ..     |
| <b>Other flagellates, etc.:</b>             |        |       |        |        |
| <i>Bodo marina</i> .....                    | 500    | 2,500 | 2,000  | 500    |
| <i>Carteria</i> sp.....                     | ..     | ..    | 500    | ..     |
| <i>Distephanus speculum</i> .....           | ..     | ..    | ..     | 100    |
| <i>Monosiga marina</i> .....                | 1,000  | 3,000 | 500    | 500    |
| <i>Phaeocystis</i> sp.....                  | rr     | +     | +      | +      |
| <i>Pterosperma cristatum</i> .....          | ..     | ..    | ..     | 100    |
| Monades and flagellates not classified..... | 13,500 | 8,000 | 13,500 | 5,500  |
| <b>Ciliates:</b>                            |        |       |        |        |
| <i>Laboea conica</i> .....                  | ..     | 100   | ..     | ..     |
| — <i>strobila</i> .....                     | ..     | 300   | ..     | ..     |
| — <i>vestita</i> .....                      | ..     | 1,100 | ..     | ..     |
| — sp.....                                   | ..     | ..    | 100    | ..     |
| <i>Lohmanniella oviformis</i> ....          | ..     | 100   | 500    | 1,500  |
| <i>Mesodinium rubrum</i> .....              | ..     | 3,500 | 500    | 100    |
| <i>Tintinnopsis beroidea</i> .....          | ..     | ..    | ..     | 100    |

Table 3.

St. 6492, Sect. R. Lat.: 55°23' N., Long.: 1°59.5' E.  
Plankton per litre. 6/5-47.

| Depth in metres                             | 0      | 10     | 20     | 30     |
|---------------------------------------------|--------|--------|--------|--------|
| Temperature, °C.....                        | 3.92   | 3.91   | 3.90   | 3.90   |
| Salinity, per mille.....                    | 34.71  | 34.70  | 34.70  | 34.70  |
| $\sigma_t$ .....                            | 27.58  | 27.57  | 27.57  | 27.57  |
| P, $\mu\text{g-atom/L}$ .....               | 0.0    | 0.0    | 0.0    | 0.0    |
| $\text{NNO}_3$ , $\mu\text{g-atom/L}$ ..... | 0.3    | 0.2    | 0.2    | 0.3    |
| $\text{O}_2$ , ml/L.....                    | 7.50   | ..     | ..     | 7.53   |
| $\text{O}_2$ , % of saturation.....         | 103.4  | ..     | ..     | 103.8  |
| Number of ml examined....                   | 2 & 10 | 2 & 10 | 2 & 10 | 2 & 10 |

|                                    |       |       |     |    |
|------------------------------------|-------|-------|-----|----|
| <b>Diatoms:</b>                    |       |       |     |    |
| <i>Actinoptychus undulatus</i> ... | ..    | 100   | ..  | .. |
| <i>Asterionella japonica</i> ..... | 1,300 | ..    | ..  | .. |
| <i>Chaetoceros affinis</i> .....   | 500   | 200   | ..  | .. |
| — <i>compressus</i> .....          | ..    | 1,200 | 800 | .. |
| — <i>constrictus</i> .....         | ..    | 400   | ..  | .. |
| — <i>convolutus</i> .....          | ..    | ..    | 100 | .. |
| — <i>danicus</i> .....             | 100   | 500   | ..  | .. |

Table 3 (continued).

| Depth in metres                              | 0      | 10     | 20     | 30     |
|----------------------------------------------|--------|--------|--------|--------|
| <i>Chaetoceros debilis</i> .....             | 4,300  | 6,100  | 700    | 1,800  |
| — <i>decipiens</i> .....                     | ..     | ..     | 200    | ..     |
| — <i>similis</i> .....                       | ..     | ..     | 200    | ..     |
| — <i>subsecundus</i> .....                   | 100    | 400    | 1,200  | ..     |
| — <i>teres</i> .....                         | ..     | ..     | 300    | ..     |
| — <i>Wighami</i> .....                       | ..     | ..     | 100    | ..     |
| — sp.....                                    | 2,900  | 8,200  | 5,900  | ..     |
| <i>Coscinodiscus concinnus</i> ....          | 100    | ..     | ..     | ..     |
| — <i>marginatus</i> .....                    | ..     | ..     | 100    | ..     |
| <i>Ditylum Brightwelli</i> .....             | ..     | 100    | ..     | ..     |
| <i>Melosira sulcata</i> .....                | 3,800  | 800    | 1,600  | ..     |
| <i>Nitzschia closterium</i> .....            | 500    | 300    | 200    | ..     |
| — <i>delicatissima</i> .....                 | 11,800 | 10,700 | 8,300  | 10,400 |
| — <i>seriata</i> .....                       | 300    | ..     | ..     | ..     |
| <i>Rhizosolenia hebet. f. semisp.</i>        | 200    | 500    | ..     | ..     |
| <i>Skeletonema costatum</i> .....            | 3,400  | 1,400  | 1,600  | ..     |
| <i>Thalassionema nitzschioides</i> .         | 200    | 600    | 200    | ..     |
| <i>Thalassiosira gravaida</i> .....          | 44,800 | 38,600 | 26,600 | 30,500 |
| — <i>Nordenskjoldi</i> .....                 | 700    | 300    | 500    | ..     |
| Pennate bottom diatoms...                    | 4,500  | 5,000  | 3,000  | ..     |
| <b>Dinoflagellates:</b>                      |        |        |        |        |
| <i>Dinophysis acuta</i> .....                | 100    | 200    | 100    | ..     |
| — <i>debilior</i> .....                      | 100    | ..     | ..     | ..     |
| <i>Goniaulax triacantha</i> .....            | 100    | ..     | ..     | ..     |
| <i>Gymnodinium</i> sp.....                   | 5,500  | 5,000  | 5,000  | ..     |
| <i>Gyrodinium</i> sp.....                    | ..     | 300    | ..     | ..     |
| <i>Peridinium globulus</i> var. <i>ovat.</i> | 200    | ..     | ..     | ..     |
| — <i>minusculum</i> .....                    | ..     | ..     | 100    | ..     |
| — <i>pallidum</i> .....                      | ..     | 100    | ..     | ..     |
| — <i>brevipes</i> .....                      | ..     | 200    | ..     | ..     |
| — sp.....                                    | 300    | ..     | 200    | ..     |
| Cysts of dinoflagellates....                 | ..     | 200    | ..     | ..     |
| <b>Coccolithophorides:</b>                   |        |        |        |        |
| <i>Coccolithus Huxleyi</i> .....             | ..     | 1,000  | ..     | ..     |
| <b>Other flagellates, etc.:</b>              |        |        |        |        |
| <i>Bodo marina</i> .....                     | 5,000  | 6,500  | 6,000  | ..     |
| <i>Carteria</i> sp.....                      | ..     | 500    | 500    | ..     |
| <i>Distephanus speculum</i> .....            | 100    | 200    | ..     | ..     |
| <i>Monosiga marina</i> .....                 | 2,000  | 1,000  | 3,000  | 1,000  |
| <i>Phaeocystis</i> sp.....                   | rr     | rr     | ..     | ..     |
| Monades and flagellates not classified.....  | 40,000 | 18,000 | 56,500 | ..     |
| <b>Ciliates:</b>                             |        |        |        |        |
| <i>Didinium parvulum</i> .....               | ..     | 100    | ..     | ..     |
| <i>Laboea conica</i> .....                   | ..     | 200    | 100    | ..     |
| — <i>strobila</i> .....                      | ..     | 600    | 200    | ..     |
| — <i>vestita</i> .....                       | ..     | 200    | ..     | ..     |
| — sp.....                                    | 100    | ..     | ..     | ..     |
| <i>Lohmanniella oviformis</i> ....           | 2,200  | 3,800  | ..     | ..     |
| <i>Mesodinium rubrum</i> .....               | 100    | 900    | 500    | ..     |
| <i>Tintinnopsis beroidea</i> .....           | 200    | 100    | ..     | ..     |

Table 4.

St. 6486, Sect. R. Lat.: 55°23' N., Long.: 3°42' E.  
Plankton per litre. 6/5-47.

| Depth in metres                                       | 0      | 10     | 20     | 27     |
|-------------------------------------------------------|--------|--------|--------|--------|
| Temperature, °C.....                                  | 5.10   | 5.07   | 5.07   | 5.07   |
| Salinity, per mille.....                              | 34.63  | 34.63  | 34.64  | 34.64  |
| $\sigma_t$ .....                                      | 27.40  | 27.40  | 27.41  | 27.41  |
| P, $\mu\text{g-atom/L}$ .....                         | 0.1    | ..     | ..     | 0.15   |
| $\text{N}_{\text{NO}_3}$ , $\mu\text{g-atom/L}$ ..... | 0.4    | ..     | ..     | 0.6    |
| $\text{O}_2$ , ml/L.....                              | 6.91   | ..     | ..     | 6.93   |
| $\text{O}_2$ , % of saturation.....                   | 98.4   | ..     | ..     | 98.4   |
| Number of ml examined.....                            | 2 & 10 | 2 & 10 | 2 & 10 | 2 & 10 |

## Diatoms:

|                                          |       |        |        |        |
|------------------------------------------|-------|--------|--------|--------|
| <i>Asterionella japonica</i> .....       | 500   | 1,300  | 2,400  | 1,900  |
| — <i>kariana</i> .....                   | ..    | ..     | 400    | ..     |
| <i>Biddulphia aurita</i> .....           | ..    | 100    | 100    | ..     |
| <i>Cerataulina Bergoni</i> .....         | ..    | ..     | ..     | 100    |
| <i>Chaetoceros borealis</i> .....        | ..    | ..     | 600    | ..     |
| — <i>ceratosporum?</i> .....             | 500   | 1,000  | 500    | 100    |
| — <i>cinctus</i> .....                   | ..    | 900    | ..     | 100    |
| — <i>compressus</i> .....                | 200   | 200    | 900    | 800    |
| — <i>curvisetus</i> .....                | 700   | 100    | ..     | 300    |
| — <i>debilis</i> .....                   | 200   | 500    | 300    | 1,100  |
| — <i>decipiens</i> .....                 | 200   | ..     | ..     | ..     |
| — <i>densus</i> .....                    | 500   | ..     | 600    | ..     |
| — <i>similis</i> .....                   | ..    | ..     | 300    | ..     |
| — <i>subsecundus</i> .....               | 300   | 2,700  | 2,300  | 1,700  |
| — <i>sp.</i> .....                       | 300   | ..     | 500    | 500    |
| <i>Coscinodiscus centralis</i> .....     | ..    | 100    | ..     | ..     |
| — <i>concinus</i> .....                  | 200   | 700    | 500    | ..     |
| — <i>oculus iridis</i> .....             | 100   | ..     | ..     | ..     |
| — <i>radiatus</i> .....                  | ..    | ..     | 200    | ..     |
| <i>Ditylum Brightwelli</i> .....         | 100   | 100    | 600    | ..     |
| <i>Leptocylinthus minimus</i> ....       | 7,500 | 16,000 | 9,500  | 12,000 |
| <i>Melosira sulcata</i> .....            | 3,700 | 2,700  | 1,900  | 4,700  |
| <i>Nitzschia closterium</i> .....        | 600   | 700    | 800    | 500    |
| — <i>delicatissima</i> .....             | 1,200 | 2,100  | 1,000  | 1,700  |
| <i>Pleurosigma fasciola</i> var....      | ..    | 100    | ..     | ..     |
| <i>Rhizosolenia fragilissima</i> ...     | 200   | ..     | ..     | ..     |
| — <i>hebetata</i> f. <i>semispina</i> .. | 100   | ..     | 200    | ..     |
| <i>Skeletonema costatum</i> .....        | 4,600 | 15,000 | 22,900 | 8,400  |
| <i>Thalassionema nitzschioides</i> .     | ..    | 1,100  | 5,100  | 400    |
| <i>Thalassiosira gravida</i> .....       | 500   | 600    | 900    | 700    |
| — <i>decipiens</i> .....                 | 1,200 | 4,900  | 8,200  | 1,900  |
| Pennate bottom diatoms....               | 4,500 | 2,500  | 6,500  | 3,500  |

## Dinoflagellates:

|                                   |       |       |       |       |
|-----------------------------------|-------|-------|-------|-------|
| <i>Ceratium lineatum</i> .....    | ..    | 100   | ..    | ..    |
| — <i>longipes</i> .....           | ..    | ..    | 100   | 100   |
| <i>Dinophysis norvegica</i> ..... | 100   | ..    | 100   | ..    |
| <i>Glenodinium lenticula</i>      |       |       |       |       |
| f. <i>asymmetrica</i> .....       | ..    | ..    | ..    | 100   |
| <i>Gymnodiniaceae</i> .....       | 2,000 | 6,000 | 4,000 | 1,000 |

Table 4 (continued).

| Depth in metres                                | 0      | 10    | 20     | 27     |
|------------------------------------------------|--------|-------|--------|--------|
| <i>Peridinium brevipes</i> .....               | 600    | 100   | 300    | 400    |
| — <i>depressum</i> .....                       | ..     | 200   | ..     | ..     |
| — <i>globulus</i> var. <i>ovatum</i> ..        | ..     | ..    | 300    | ..     |
| — <i>leonis</i> .....                          | ..     | ..    | 100    | ..     |
| — <i>minusculum</i> .....                      | ..     | ..    | ..     | 100    |
| — <i>trochoideum</i> .....                     | 200    | ..    | ..     | 200    |
| <i>Phalacroma rotundatum</i> ...               | ..     | 100   | 100    | ..     |
| Other flagellates, etc.:                       |        |       |        |        |
| <i>Bodo marina</i> .....                       | 6,000  | 9,500 | 7,500  | 1,000  |
| <i>Carteria</i> sp.....                        | 3,500  | 8,500 | 8,000  | 6,000  |
| <i>Distephanus speculum</i> .....              | ..     | ..    | 100    | 100    |
| <i>Monosiga marina</i> .....                   | ..     | 500   | ..     | ..     |
| <i>Phaeocystis</i> sp.....                     | rr     | rr    | ..     | ..     |
| Monades and flagellates not<br>classified..... | 17,500 | 8,500 | 14,000 | 15,500 |
| Ciliates:                                      |        |       |        |        |
| <i>Didinium parvulum</i> .....                 | ..     | ..    | 100    | ..     |
| <i>Laboea conica</i> .....                     | ..     | ..    | 200    | ..     |
| — <i>emergens</i> .....                        | ..     | 300   | 300    | ..     |
| — <i>strobila</i> .....                        | ..     | 200   | ..     | ..     |
| — <i>vestita</i> .....                         | ..     | 200   | 400    | ..     |
| — <i>sp.</i> .....                             | 100    | 500   | ..     | ..     |
| <i>Lohmanniella oviformis</i> ....             | 400    | 600   | 400    | 300    |
| <i>Mesodinium rubrum</i> .....                 | ..     | 300   | 100    | ..     |
| <i>Ptychocylis urnula</i> .....                | 200    | 200   | 200    | 100    |
| <i>Strombidium</i> sp.....                     | ..     | 400   | 200    | ..     |
| <i>Tintinnopsis beroidea</i> .....             | 400    | 100   | 500    | 200    |

Table 5.

St. 6479, Sect. R. Lat.: 55°23' N., Long.: 6°43.5' E.  
Plankton per litre. 5/5-47.

| Depth in metres                                       | 0      | 10     | 20     | 27     |
|-------------------------------------------------------|--------|--------|--------|--------|
| Temperature, °C.....                                  | 3.60   | 3.49   | 3.46   | 3.46   |
| Salinity, per mille.....                              | 33.82  | 33.89  | 33.91  | 33.91  |
| $\sigma_t$ .....                                      | 26.91  | 26.97  | 26.99  | 26.99  |
| P, $\mu\text{g-atom/L}$ .....                         | 0.0    | 0.0    | 0.0    | 1.0    |
| $\text{N}_{\text{NO}_3}$ , $\mu\text{g-atom/L}$ ..... | 0.8    | 0.8    | 1.2    | 0.5    |
| $\text{O}_2$ , ml/L.....                              | 7.38   | ..     | ..     | 7.40   |
| $\text{O}_2$ , % of saturation.....                   | 100.4  | ..     | ..     | 100.4  |
| Number of ml examined.....                            | 2 & 10 | 2 & 10 | 2 & 10 | 2 & 10 |

## Diatoms:

|                                   |     |       |       |       |
|-----------------------------------|-----|-------|-------|-------|
| <i>Asterionella kariana</i> ..... | ..  | ..    | 1,300 | ..    |
| <i>Biddulphia aurita</i> .....    | ..  | ..    | 400   | ..    |
| <i>Chaetoceros affinis</i> .....  | ..  | 4,100 | 7,800 | 2,600 |
| — <i>borealis</i> .....           | ..  | ..    | 200   | ..    |
| — <i>cinctus</i> .....            | ..  | ..    | ..    | 500   |
| — <i>compressus</i> .....         | ..  | 200   | 1,800 | 500   |
| — <i>debilis</i> .....            | 100 | ..    | ..    | 800   |
| — <i>decipiens</i> .....          | ..  | 200   | ..    | ..    |

Table 5 (continued).

| Depth in metres .....                            | 0     | 10    | 20    | 27    |
|--------------------------------------------------|-------|-------|-------|-------|
| <i>Chaetoceros subsecundus</i> ...               | 600   | 1,000 | 700   | 2,400 |
| <i>Coscinodiscus concinnus</i> ....              | 500   | 700   | 300   | ..    |
| <i>Leptocylindrus danicus</i> ....               | ..    | ..    | 300   | ..    |
| — <i>minimus</i> .....                           | ..    | ..    | 300   | ..    |
| <i>Melosira italica</i> .....                    | ..    | ..    | 500   | 600   |
| — <i>sulcata</i> .....                           | 100   | 2,800 | ..    | 200   |
| <i>Nitzschia closterium</i> .....                | 100   | ..    | ..    | ..    |
| — <i>delicatissima</i> .....                     | ..    | ..    | 400   | 200   |
| <i>Skeletonema costatum</i> .....                | ..    | 1,200 | 600   | 2,700 |
| <i>Thalassionema nitzschioides</i> ..            | 200   | ..    | ..    | ..    |
| <i>Thalassiosira gravida</i> .....               | 500   | 1,600 | 1,300 | 800   |
| — <i>Nordenskjoeldi</i> .....                    | ..    | 400   | 700   | ..    |
| — <i>decipiens</i> .....                         | 1,400 | 1,700 | 2,700 | 1,700 |
| Pennate bottom diatoms...                        | 2,000 | 5,000 | 4,000 | 5,500 |
| <b>Dinoflagellates:</b>                          |       |       |       |       |
| <i>Dinophysis acuta</i> .....                    | 100   | ..    | ..    | ..    |
| <i>Gymnodinium</i> sp. ....                      | ..    | 1,300 | 600   | 300   |
| <i>Gymnodiniaceae</i> .....                      | 200   | ..    | 500   | ..    |
| <i>Peridinium globulus</i> var. <i>ovatum</i> .. | 100   | ..    | 300   | 100   |
| — <i>leonis</i> .....                            | ..    | ..    | ..    | 200   |
| — <i>pellucidum</i> .....                        | ..    | ..    | ..    | 200   |
| — <i>subinermis</i> .....                        | 100   | 100   | ..    | ..    |
| — <i>trochoideum</i> .....                       | 300   | 300   | 200   | ..    |
| <i>Protoceratium reticulatum</i> ..              | ..    | ..    | ..    | 100   |
| <b>Other flagellates, etc.:</b>                  |       |       |       |       |
| <i>Carteria</i> sp. ....                         | ..    | ..    | 1,000 | 1,500 |
| <i>Monosiga marina</i> .....                     | 500   | ..    | 1,500 | 500   |
| <i>Distephanus speculum</i> .....                | ..    | ..    | 100   | ..    |
| <i>Pterosperma cristatum</i> .....               | 100   | ..    | ..    | 100   |
| Monades and flagellates not classified.....      | 4,000 | 4,000 | 4,500 | 3,500 |
| <b>Ciliates:</b>                                 |       |       |       |       |
| <i>Laboea conica</i> .....                       | ..    | 600   | 200   | 100   |
| — <i>strobila</i> .....                          | ..    | 200   | ..    | ..    |
| — <i>vestita</i> .....                           | 100   | ..    | ..    | ..    |
| — <i>sp.</i> .....                               | ..    | 400   | ..    | ..    |
| <i>Lohmanniella oviformis</i> ....               | 700   | 700   | 800   | 100   |
| <i>Mesodinium rubrum</i> .....                   | ..    | 300   | 200   | 100   |
| <i>Tintinnopsis beroidea</i> .....               | 100   | 100   | 400   | 100   |

Table 6.

St. 6505, Sect. S. Lat.: 54°30' N., Long.: 0°18.5' W.  
Plankton per litre. 7/5-47.

| Depth in metres .....                           | 0       | 10      | 20      | 53      |
|-------------------------------------------------|---------|---------|---------|---------|
| Temperature, °C.....                            | 5.60    | 5.48    | 5.49    | 5.50    |
| Salinity, per mille.....                        | 34.37   | 34.38   | 34.38   | 34.43   |
| <i>σ<sub>t</sub></i> .....                      | 27.13   | 27.15   | 27.15   | 27.19   |
| P, µg-atom/L .....                              | ..      | ..      | ..      | ..      |
| N <sub>2</sub> NO <sub>3</sub> , µg-atom/L..... | 15.0    | ..      | 10.0    | 12.0    |
| O <sub>2</sub> , ml/L .....                     | 7.02    | ..      | ..      | ..      |
| O <sub>2</sub> , % of saturation .....          | 99.3    | ..      | ..      | ..      |
| Number of ml examined.....                      | 2 & 10  | 2 & 10  | 2 & 10  | 2 & 10  |
| <b>Diatoms:</b>                                 |         |         |         |         |
| <i>Actinocyclus undulatus</i> ....              | ..      | ..      | 100     | 100     |
| <i>Asterionella Bleakeleyi</i> ....             | ..      | 1,700   | ..      | ..      |
| — <i>japonica</i> .....                         | 38,600  | 49,600  | 72,500  | 70,000  |
| — <i>kariana</i> .....                          | ..      | ..      | 2,100   | 1,400   |
| <i>Chaetoceros affinis</i> .....                | 1,200   | 1,700   | 400     | ..      |
| — <i>cinctus</i> .....                          | 22,200  | 7,700   | 18,800  | 10,100  |
| — <i>compressus</i> .....                       | 19,600  | 11,900  | 12,000  | 10,700  |
| — <i>curvisetus</i> .....                       | ..      | ..      | 200     | ..      |
| — <i>debilis</i> .....                          | 4,800   | 7,800   | 7,000   | 6,000   |
| — <i>decipiens</i> .....                        | ..      | ..      | 500     | 200     |
| — <i>gracilis?</i> .....                        | 1,200   | 500     | ..      | ..      |
| — <i>subsecundus</i> .....                      | 3,800   | 4,500   | 7,200   | 3,100   |
| <i>Coscinosira polychorda</i> ....              | ..      | ..      | ..      | 1,100   |
| <i>Ditylum Brightwelli</i> .....                | 100     | 100     | 400     | 400     |
| <i>Leptocylindrus minimus</i> ....              | 2,100   | 1,100   | ..      | ..      |
| <i>Melosira sulcata</i> .....                   | 1,900   | 3,100   | 4,100   | 16,700  |
| <i>Nitzschia closterium</i> .....               | 6,900   | 11,400  | 9,100   | 4,300   |
| — <i>delicatissima</i> .....                    | 53,400  | 38,000  | 88,400  | 183,000 |
| — <i>seriata</i> .....                          | 800     | 2,300   | 1,400   | 500     |
| <i>Pleurosira aestuarii</i> .....               | ..      | ..      | 100     | 100     |
| <i>Rhizosolenia fragilissima</i> ...            | ..      | ..      | 100     | ..      |
| — <i>hebetata</i> f. <i>semispina</i> ..        | ..      | 300     | ..      | ..      |
| <i>Skeletonema costatum</i> .....               | 280,000 | 397,000 | 754,000 | 460,000 |
| <i>Thalassionema nitzschioides</i> ..           | 2,600   | 8,700   | 15,100  | 9,800   |
| <i>Thalassiosira gravida</i> .....              | 600     | 300     | ..      | 700     |
| — <i>Nordenskjoeldi</i> .....                   | 2,000   | 1,900   | 9,100   | ..      |
| — <i>decipiens</i> .....                        | 49,600  | 65,800  | 72,700  | 75,000  |
| Pennate bottom diatoms...                       | 9,000   | 9,500   | 6,000   | 6,500   |
| <b>Dinoflagellates:</b>                         |         |         |         |         |
| <i>Goniaulax spinifera</i> .....                | ..      | ..      | ..      | 100     |
| <i>Peridinium trochoideum</i> ....              | 100     | ..      | ..      | ..      |
| <i>Gymnodiniaceae</i> .....                     | 100     | 100     | 100     | ..      |
| <i>Protoceratium reticulatum</i> ..             | 100     | ..      | ..      | ..      |
| <b>Other flagellates, etc.:</b>                 |         |         |         |         |
| <i>Bodo marina</i> .....                        | 2,000   | 500     | 1,000   | 500     |
| <i>Monosiga marina</i> .....                    | 2,000   | 2,500   | 5,000   | 500     |
| <i>Distephanus speculum</i> .....               | 200     | 100     | ..      | 200     |
| <i>Pterosperma cristatum</i> .....              | ..      | ..      | 100     | ..      |
| Monades and flagellates not classified.....     | 2,500   | 7,500   | 1,500   | 2,000   |

Table 6 (continued).

| Depth in metres        | 0   | 10  | 20  | 53  |
|------------------------|-----|-----|-----|-----|
| Lohmanniella oviformis | 100 | 200 | 100 | 100 |
| Mesodinium rubrum      | 200 | 100 | 100 | ..  |
| Ptychocylis urnula     | ..  | 100 | ..  | 100 |
| Tintinnopsis beroidea  | ..  | ..  | 100 | ..  |

Table 7.

St. 6508, Sect. S. Lat.: 54°30' N., Long.: 0°33' E.  
Plankton per litre. 7/5-47.

| Depth in metres                              | 0      | 10     | 20     | 59     |
|----------------------------------------------|--------|--------|--------|--------|
| Temperature, °C.                             | 5.77   | 5.62   | 5.61   | 5.60   |
| Salinity, per mille                          | 34.70  | 34.72  | 34.72  | 34.72  |
| $\sigma_t$                                   | 27.36  | 27.40  | 27.40  | 27.40  |
| P, $\mu$ g-atom/L                            | 0.0    | ..     | 0.1    | 0.1    |
| N <sub>NO<sub>3</sub></sub> , $\mu$ g-atom/L | 6.5    | ..     | 7.0    | 6.5    |
| O <sub>2</sub> , ml/L                        | 7.02   | ..     | ..     | 6.99   |
| O <sub>2</sub> , % of saturation             | 101.3  | ..     | ..     | 100.6  |
| Number of ml examined                        | 2 & 10 | 2 & 10 | 2 & 10 | 2 & 10 |

## Diatoms:

|                             |        |        |         |         |
|-----------------------------|--------|--------|---------|---------|
| Actinoptychus undulatus     | ..     | 100    | 200     | 1,500   |
| Asterionella Bleakeleyi     | 100    | ..     | ..      | ..      |
| — japonica                  | 600    | 3,600  | 12,800  | 25,000  |
| Chaetoceros affinis         | ..     | 600    | ..      | ..      |
| — cinctus                   | 1,600  | 12,100 | 17,800  | 45,000  |
| — compressus                | 10,600 | 56,000 | 121,800 | 445,500 |
| — debilis                   | 1,900  | 6,000  | 12,400  | 35,500  |
| — decipiens                 | ..     | 200    | 800     | 2,000   |
| — gracilis?                 | ..     | 1,500  | 500     | 1,500   |
| — subsecundus               | 4,000  | 22,200 | 37,000  | 213,000 |
| — sp.                       | 200    | 2,200  | 600     | ..      |
| Coscinodiscus excentricus   | ..     | ..     | ..      | 500     |
| Ditylum Brightwelli         | 400    | 900    | 2,200   | 11,500  |
| Melosira sulcata            | 3,200  | 3,600  | 9,000   | 20,000  |
| Nitzschia closterium        | 800    | 2,200  | 2,000   | 6,000   |
| — delicatissima             | 200    | 600    | 1,400   | 11,000  |
| Pleurosigma aestuarii       | ..     | ..     | 200     | 500     |
| Rhizosolenia alata          | ..     | ..     | ..      | 500     |
| — hebetata f. semispina     | ..     | 100    | ..      | ..      |
| Skeletonema costatum        | 8,500  | 30,000 | 92,000  | 442,000 |
| Thalassionema nitzschioides | ..     | 3,300  | 11,800  | 6,500   |
| Thalassiosira gravida       | 100    | 700    | 1,200   | 2,000   |
| — Nordenskjöldi             | 200    | 1,700  | 600     | 3,500   |
| — decipiens                 | 500    | 4,800  | 8,200   | 25,000  |
| Pennate bottom diatoms      | 2,500  | 6,500  | 12,500  | 29,500  |

## Dinoflagellates:

|                                       |     |       |       |     |
|---------------------------------------|-----|-------|-------|-----|
| Ceratium lineatum                     | 100 | ..    | ..    | ..  |
| Glennodinium lenticula f. asymmetrica | 100 | ..    | 200   | ..  |
| Gymnodiniaceae                        | 500 | 1,500 | 1,000 | 500 |

Table 7 (continued).

| Depth in metres                        | 0     | 10    | 20    | 59    |
|----------------------------------------|-------|-------|-------|-------|
| Peridinium depressum                   | ..    | 200   | ..    | ..    |
| — pallidum                             | ..    | 100   | ..    | ..    |
| — trochoideum                          | 800   | 500   | 500   | 500   |
| Other flagellates, etc.:               |       |       |       |       |
| Bodo marina                            | 1,000 | 3,500 | 3,500 | 1,000 |
| Distephanus speculum                   | ..    | ..    | 800   | 1,500 |
| Pterosperma cristatum                  | ..    | ..    | 200   | ..    |
| Monates and flagellates not classified | 4,000 | 1,000 | 3,500 | 1,000 |
| Ciliates:                              |       |       |       |       |
| Lohmanniella oviformis                 | 100   | 600   | 200   | 500   |
| Mesodinium rubrum                      | ..    | 100   | 400   | ..    |
| Tintinnopsis beroidea                  | ..    | ..    | 400   | ..    |

Table 8.

St. 6514, Sect. S. Lat.: 54°30' N., Long.: 2°18' E.  
Plankton per litre. 7/5-47.

| Depth in metres                              | 0      | 14     |
|----------------------------------------------|--------|--------|
| Temperature, °C.                             | 5.80   | 5.75   |
| Salinity, per mille                          | 34.79  | 34.83  |
| $\sigma_t$                                   | 27.43  | 27.47  |
| P, $\mu$ g-atom/L                            | 0.0    | 0.0    |
| N <sub>NO<sub>3</sub></sub> , $\mu$ g-atom/L | 3.0    | 0.9    |
| O <sub>2</sub> , ml/L                        | 7.01   | 7.02   |
| O <sub>2</sub> , % of saturation             | 101.4  | 101.4  |
| Number of ml examined                        | 2 & 10 | 2 & 10 |

## Diatoms:

|                             |       |        |
|-----------------------------|-------|--------|
| Actinoptychus undulatus     | ..    | 100    |
| Asterionella japonica       | 100   | 600    |
| Chaetoceros borealis        | 700   | 1,100  |
| — compressus                | 3,100 | 3,400  |
| — debilis                   | ..    | 1,400  |
| — decipiens                 | ..    | 900    |
| — subsecundus               | 700   | 3,000  |
| — teres                     | ..    | 300    |
| Coscinodiscus concinnus     | 200   | ..     |
| — radiatus                  | ..    | 200    |
| Melosira sulcata            | 400   | ..     |
| Nitzschia closterium        | 300   | 300    |
| — delicatissima             | 9,600 | 31,100 |
| — seriata                   | 1,200 | ..     |
| Pleurosigma aestuarii       | 100   | 200    |
| Skeletonema costatum        | 2,000 | 2,700  |
| Thalassionema nitzschioides | 1,500 | 3,800  |
| Thalassiosira decipiens     | 2,500 | 1,800  |
| — gravida                   | 100   | 500    |
| — Nordenskjöldi             | 100   | 100    |
| Pennate bottom diatoms      | 5,500 | 4,500  |

Table 8 (continued).

| Depth in metres.....                     | 0     | 14    |
|------------------------------------------|-------|-------|
| Dinoflagellates:                         |       |       |
| Amphidinium sp. ....                     | ..    | 100   |
| Peridinium minusculum .....              | 100   | 100   |
| — trochoideum.....                       | 300   | ..    |
| Phalacroma rotundatum.....               | ..    | 100   |
| Cysts of dinoflagellates.....            | 100   | ..    |
| Other flagellates, etc.:                 |       |       |
| Bodo marina.....                         | 1,500 | 5,000 |
| Phaeocystis sp.....                      | rr    | rr    |
| Monades and flagellates not classified.. | 2,500 | 3,500 |
| Ciliates:                                |       |       |
| Lohmanniella oviformis.....              | ..    | 400   |

Table 9.

St. 6525, Sect. S. Lat.: 54°18' N., Long.: 4°46' E.  
Plankton per litre. 8/5-47.

| Depth in metres .....                       | 0      | 10     | 20     | 39     |
|---------------------------------------------|--------|--------|--------|--------|
| Temperature, °C.....                        | 5.84   | 5.73   | 5.25   | 5.24   |
| Salinity, per mille.....                    | 34.52  | 34.51  | 34.51  | 34.52  |
| $\sigma_t$ .....                            | 27.22  | 27.22  | 27.28  | 27.26  |
| P, $\mu\text{g-atom/L}$ .....               | 0.3    | ..     | 0.15   | 0.2    |
| $\text{NNO}_3$ , $\mu\text{g-atom/L}$ ..... | 32.0   | ..     | 12.0   | 18.0   |
| $\text{O}_2$ , ml/L .....                   | 7.08   | ..     | ..     | 6.98   |
| $\text{O}_2$ , % of saturation .....        | 102.2  | ..     | ..     | 99.5   |
| Number of ml examined.....                  | 2 & 10 | 2 & 10 | 2 & 10 | 2 & 10 |

## Diatoms:

|                                |       |       |        |        |
|--------------------------------|-------|-------|--------|--------|
| Actinopterychus undulatus...   | ..    | ..    | 400    | 300    |
| Asterionella japonica.....     | ..    | ..    | 2,100  | 2,100  |
| Biddulphia aurita .....        | ..    | ..    | ..     | 100    |
| Campylosira cymbelliformis.    | ..    | ..    | 1,100  | 1,000  |
| Cerataulina Bergoni .....      | ..    | ..    | ..     | 200    |
| Chaetoceros danicus .....      | 100   | ..    | ..     | ..     |
| — debilis.....                 | ..    | 200   | 800    | 300    |
| — densus .....                 | ..    | ..    | ..     | 200    |
| — subsecundus .....            | ..    | ..    | ..     | 100    |
| Coscinodiscus radiatus .....   | ..    | 100   | 400    | 100    |
| Melosira sulcata.....          | 900   | 4,300 | 7,700  | 27,300 |
| Nitzschia closterium .....     | 1,800 | 1,800 | 10,600 | 8,500  |
| — delicatissima .....          | 1,500 | 2,700 | 3,000  | 5,900  |
| — seriata .....                | ..    | 2,700 | ..     | ..     |
| Rhizosolenia hebet. f. semisp. | ..    | ..    | 300    | 100    |
| — imbricata var. Shrubsolei    | ..    | ..    | ..     | 100    |
| — setigera.....                | ..    | ..    | ..     | 100    |
| Skeletonema costatum .....     | 1,200 | ..    | 7,500  | 6,600  |
| Thalassionema nitzschioides.   | 500   | 500   | 4,300  | 3,800  |
| Thalassiosira decipiens .....  | 1,500 | 600   | 2,200  | 2,400  |
| — gravida.....                 | ..    | 800   | 2,100  | 5,400  |
| — Nordenskjoeldi .....         | ..    | ..    | ..     | 200    |

Table 9 (continued).

| Depth in metres .....                       | 0      | 10     | 20     | 39     |
|---------------------------------------------|--------|--------|--------|--------|
| Thalassiothrix longissima...                | ..     | ..     | ..     | 100    |
| Pennate bottom diatoms...                   | 10,500 | 12,000 | 29,500 | 38,000 |
| Dinoflagellates:                            |        |        |        |        |
| Ceratium lineatum.....                      | 100    | ..     | ..     | ..     |
| — longipes .....                            | 100    | ..     | ..     | ..     |
| Glenodinium lenticula f.                    |        |        |        |        |
| asymmetrica .....                           | 200    | 100    | ..     | ..     |
| Gymnodiniaceae.....                         | 1,000  | 2,000  | ..     | 1,500  |
| Peridinium depressum .....                  | 100    | ..     | ..     | ..     |
| — globulus var. ovatum ..                   | ..     | 100    | 100    | ..     |
| — trochoideum .....                         | 200    | ..     | ..     | ..     |
| Pyrocystis lunula.....                      | 100    | 100    | ..     | ..     |
| Other flagellates, etc.:                    |        |        |        |        |
| Bodo marina.....                            | ..     | 500    | 2,500  | 1,500  |
| Carteria sp.....                            | 3,000  | 1,000  | 1,500  | 1,000  |
| Distephanus speculum .....                  | ..     | 100    | ..     | 200    |
| Pterosperma cristatum.....                  | 100    | ..     | 100    | ..     |
| Monades and flagellates not classified..... | 1,500  | 6,000  | 1,500  | 2,500  |
| Ciliates:                                   |        |        |        |        |
| Laboea conica .....                         | ..     | 200    | ..     | ..     |
| — constricta.....                           | ..     | 200    | ..     | ..     |
| — strobila .....                            | ..     | 300    | ..     | ..     |
| — sp.....                                   | ..     | 200    | ..     | ..     |
| Lohmanniella oviformis....                  | 100    | ..     | 300    | ..     |
| Mesodinium rubrum .....                     | ..     | 600    | ..     | ..     |
| Woodania conicoides.....                    | ..     | 500    | ..     | ..     |

Table 10.

St. 6528, Sect. S. Lat.: 54°17.5' N., Long.: 5°35' E.  
Plankton per litre. 8/5-47.

| Depth in metres .....                       | 0      | 10     | 20     | 35     |
|---------------------------------------------|--------|--------|--------|--------|
| Temperature, °C.....                        | 7.22   | 6.52   | 6.09   | 6.08   |
| Salinity, per mille.....                    | 34.28  | 34.33  | 34.33  | 34.33  |
| $\sigma_t$ .....                            | 26.85  | 26.98  | 27.04  | 27.04  |
| P, $\mu\text{g-atom/L}$ .....               | 0.0    | ..     | ..     | 0.0    |
| $\text{NNO}_3$ , $\mu\text{g-atom/L}$ ..... | 3.0    | ..     | ..     | 3.0    |
| $\text{O}_2$ , ml/L .....                   | 6.96   | ..     | ..     | 6.84   |
| $\text{O}_2$ , % of saturation .....        | 103.7  | ..     | ..     | 99.3   |
| Number of ml examined.....                  | 2 & 10 | 2 & 10 | 2 & 10 | 2 & 10 |

## Diatoms:

|                             |     |     |     |       |
|-----------------------------|-----|-----|-----|-------|
| Asterionella japonica.....  | ..  | ..  | 900 | 1,400 |
| — kariana .....             | ..  | ..  | ..  | 600   |
| Biddulphia aurita .....     | ..  | 300 | ..  | ..    |
| — rhombus.....              | ..  | ..  | ..  | 100   |
| Campylosira cymbelliformis. | ..  | ..  | ..  | 100   |
| Cerataulina Bergoni .....   | 100 | 100 | 500 | 300   |
| Chaetoceros subsecundus ... | ..  | ..  | 400 | ..    |

Table 10 (continued).

| Depth in metres .....        | 0      | 10     | 20     | 35     |
|------------------------------|--------|--------|--------|--------|
| Chaetoceros sp.....          | ..     | ..     | 400    | ..     |
| Melosira sulcata.....        | 100    | 100    | 5,900  | 2,400  |
| — sp.....                    | ..     | ..     | 600    | ..     |
| Nitzschia closterium.....    | ..     | 100    | 200    | 200    |
| — delicatissima.....         | 800    | 900    | 15,400 | 2,900  |
| Rhizosolenia imbricata var.  |        |        |        |        |
| Shrubsolai.....              | ..     | ..     | 100    | 600    |
| Skeletonema costatum.....    | ..     | ..     | 700    | 400    |
| Thalassionema nitzschioides. | ..     | ..     | 200    | 500    |
| Thalassiosira decipiens..... | ..     | ..     | 500    | ..     |
| — gravis.....                | ..     | 300    | 1,800  | 2,500  |
| — Nordenskjöldi.....         | ..     | 200    | ..     | ..     |
| Pennate bottom diatoms...    | 2,500  | 4,000  | 10,000 | 4,000  |
| Dinoflagellates:             |        |        |        |        |
| Exuviaella baltica.....      | 4,500  | 400    | ..     | ..     |
| Glenodinium lenticula f.     |        |        |        |        |
| asymmetrica.....             | 100    | ..     | 100    | 100    |
| Gymnodiniaceae.....          | 4,500  | 1,500  | 1,500  | 1,500  |
| Peridinium depressum.....    | 400    | 100    | ..     | ..     |
| — globulus var. ovatum..     | 3,100  | 1,300  | 1,600  | 1,100  |
| — pellucidum.....            | ..     | 100    | ..     | ..     |
| — sp.....                    | 100    | 200    | 100    | 100    |
| Phalacroma rotundatum...     | 100    | 100    | ..     | ..     |
| Cysts of dinoflagellates.... | 200    | ..     | ..     | ..     |
| Other flagellates, etc.:     |        |        |        |        |
| Bodo marina.....             | 5,500  | 7,000  | 9,500  | 1,000  |
| Carteria sp.....             | 4,000  | 2,500  | 1,000  | ..     |
| Distephanus speculum.....    | ..     | ..     | 200    | 300    |
| Monosiga marina.....         | ..     | ..     | 500    | ..     |
| Phaeocystis sp.....          | ..     | ..     | r      | rr     |
| Pterosperma cristatum.....   | ..     | ..     | ..     | 200    |
| Monades and flagellates not  |        |        |        |        |
| classified.....              | 21,500 | 17,500 | 13,000 | 11,000 |
| Ciliates:                    |        |        |        |        |
| Laboea conica.....           | ..     | 100    | ..     | ..     |
| — sp.....                    | 100    | ..     | ..     | ..     |
| Mesodinium rubrum.....       | 600    | 1,200  | 100    | 200    |
| Ptychocyclus urnula.....     | 100    | ..     | ..     | ..     |
| Tintinnopsis beroidea.....   | 800    | 300    | 100    | 100    |

Table 11.

St. 6531, Sect. S. Lat.: 54°17' N., Long.: 6°27' E.  
Plankton per litre. 8/5-47.

| Depth in metres .....                       | 0      | 10     | 20     | 30     |
|---------------------------------------------|--------|--------|--------|--------|
| Temperature, °C.....                        | 5.02   | 4.72   | 4.60   | 4.59   |
| Salinity, per mille.....                    | 33.96  | 33.98  | 33.98  | 33.97  |
| $\sigma_t$ .....                            | 26.87  | 26.91  | 26.92  | 26.93  |
| P, $\mu\text{g-atom/L}$ .....               | 0.1    | ..     | ..     | 0.1    |
| $\text{NNO}_3$ , $\mu\text{g-atom/L}$ ..... | 11.0   | ..     | ..     | 22.0   |
| $\text{O}_2$ , ml/L.....                    | 7.27   | ..     | ..     | 7.23   |
| $\text{O}_2$ , % of saturation.....         | 102.4  | ..     | ..     | 100.9  |
| Number of ml examined.....                  | 2 & 10 | 2 & 10 | 2 & 10 | 2 & 10 |
| Diatoms:                                    |        |        |        |        |
| Asterionella japonica.....                  | ..     | 2,500  | 5,000  | 6,200  |
| — kariana.....                              | ..     | ..     | ..     | 1,100  |
| Biddulphia aurita.....                      | ..     | 1,700  | 800    | ..     |
| Cerataulina Bergoni.....                    | ..     | 100    | 700    | ..     |
| Chaetoceros atlanticus.....                 | ..     | ..     | ..     | 200    |
| — borealis.....                             | 200    | 100    | ..     | 200    |
| — cinctus.....                              | ..     | ..     | ..     | 11,300 |
| — compressus.....                           | ..     | 1,400  | ..     | ..     |
| — curviretus.....                           | ..     | 300    | 400    | ..     |
| — danicus.....                              | ..     | ..     | 200    | ..     |
| — debilis.....                              | ..     | 100    | 600    | 600    |
| — decipiens.....                            | ..     | ..     | ..     | 1,200  |
| — socialis.....                             | 300    | ..     | 500    | ..     |
| — subsecundus.....                          | 100    | 800    | 900    | 1,400  |
| — sp.....                                   | ..     | 900    | ..     | 800    |
| Coscinodiscus concinnus....                 | 100    | ..     | 100    | ..     |
| — radiatus.....                             | ..     | ..     | 100    | 100    |
| Coscinosira polychorda.....                 | ..     | ..     | 300    | ..     |
| Ditylum Brightwelli.....                    | ..     | ..     | 100    | ..     |
| Leptocylindrus minimus....                  | ..     | 200    | ..     | ..     |
| Melosira sulcata.....                       | ..     | 4,900  | 1,700  | 900    |
| Nitzschia closterium.....                   | 5,800  | 3,200  | 9,400  | 5,100  |
| delicatissima.....                          | 1,500  | 1,900  | 900    | 5,200  |
| seriata.....                                | ..     | 200    | ..     | 1,300  |
| Podosira stelliger.....                     | ..     | ..     | 200    | ..     |
| Rhizosolenia alata.....                     | ..     | ..     | ..     | 100    |
| — hebetata f. semispina..                   | ..     | ..     | ..     | 100    |
| — imbricata var. Shrubsolai                 | 100    | ..     | ..     | ..     |
| — setigera.....                             | 100    | ..     | ..     | ..     |
| — styliformis.....                          | ..     | ..     | ..     | 100    |
| Skeletonema costatum.....                   | 1,000  | 1,800  | 3,400  | 2,900  |
| Thalassionema nitzschioides.                | 1,200  | 400    | 1,700  | 400    |
| Thalassiosira decipiens.....                | 800    | 1,000  | 2,400  | 3,000  |
| — gravis.....                               | 200    | 100    | 800    | 700    |
| — Nordenskjöldi.....                        | 200    | ..     | ..     | 700    |
| Pennate bottom diatoms...                   | 8,500  | 4,500  | 12,500 | 10,500 |
| Dinoflagellates:                            |        |        |        |        |
| Ceratium tripos.....                        | ..     | ..     | ..     | 100    |
| Exuviaella baltica.....                     | ..     | ..     | 100    | ..     |
| Gymnodinium sp.....                         | 500    | ..     | 500    | ..     |

Table 11 (continued).

| Depth in metres .....                           | 0      | 10    | 20    | 30    |
|-------------------------------------------------|--------|-------|-------|-------|
| Peridinium globulus var. ovat.                  | 400    | 700   | 100   | 900   |
| — trochoideum .....                             | 100    | 100   | 400   | 300   |
| Couelithophorides:                              |        |       |       |       |
| Cysts of dinoflagellates .....                  | ..     | 100   | ..    | 100   |
| Rhabdosphaera hispida .....                     | 500    | ..    | ..    | ..    |
| Other flagellates, etc.:                        |        |       |       |       |
| Bodo marina .....                               | ..     | 2,500 | 2,000 | 2,000 |
| Carteria sp. ....                               | 1,500  | 500   | 2,500 | ..    |
| Distephanus speculum .....                      | ..     | ..    | 200   | ..    |
| Euglena sp. ....                                | ..     | ..    | 100   | ..    |
| Monosiga marina .....                           | 1,500  | 1,000 | 2,500 | ..    |
| Phaeocystis sp. ....                            | rr     | rr    | ..    | rr    |
| Pterosperma cristatum .....                     | 500    | ..    | ..    | ..    |
| Monades and flagellates not<br>classified ..... | 16,000 | 8,000 | 8,500 | 7,500 |
| Ciliates:                                       |        |       |       |       |
| Laboea conica .....                             | ..     | ..    | 100   | ..    |
| — strobila .....                                | ..     | ..    | 100   | ..    |
| Lohmanniella oviformis .....                    | 300    | 100   | 100   | 200   |
| Mesodinium rubrum .....                         | 4,000  | 800   | 400   | 300   |
| Tintinnopsis beroidea .....                     | 100    | ..    | 100   | ..    |

Table 12.

St. 6534, Sect. S. Lat.: 54°16' N., Long.: 7°11.5' E.  
Plankton per litre. 8/5-47.

| Depth in metres .....                       | 0      | 10     | 20     | 32     |
|---------------------------------------------|--------|--------|--------|--------|
| Temperature, °C .....                       | 4.40   | 4.33   | 4.00   | 3.99   |
| Salinity, per mille .....                   | 33.92  | 33.92  | 33.98  | 34.04  |
| $\sigma_t$ .....                            | 26.91  | 26.91  | 26.99  | 27.04  |
| P, $\mu\text{g-atom/L}$ .....               | 0.1    | ..     | ..     | 0.2    |
| $\text{NNO}_3$ , $\mu\text{g-atom/L}$ ..... | 10.0   | ..     | ..     | 10.0   |
| $\text{O}_2$ , ml/L .....                   | 7.32   | ..     | ..     | 7.37   |
| $\text{O}_2$ , % of saturation .....        | 101.7  | ..     | ..     | 101.5  |
| Number of ml examined .....                 | 2 & 10 | 2 & 10 | 2 & 10 | 2 & 10 |

## Diatoms:

|                               |     |       |       |        |
|-------------------------------|-----|-------|-------|--------|
| Asterionella japonica .....   | ..  | 100   | 800   | ..     |
| — kariana .....               | 100 | ..    | ..    | ..     |
| Biddulphia aurita .....       | ..  | 1,400 | 200   | 1,500  |
| Cerataulina Bergoni .....     | 100 | ..    | 200   | ..     |
| Chaetoceros affinis .....     | ..  | 2,000 | ..    | 44,000 |
| — borealis .....              | ..  | ..    | 700   | 400    |
| — cinctus .....               | ..  | 100   | ..    | ..     |
| — compressus .....            | ..  | 300   | ..    | ..     |
| — danicus .....               | ..  | 100   | ..    | ..     |
| — debilis .....               | ..  | ..    | ..    | 500    |
| — densus .....                | ..  | 300   | ..    | 200    |
| — subsecundus .....           | ..  | 600   | 1,000 | 900    |
| Coscinodiscus concinnus ..... | 100 | ..    | ..    | ..     |

Table 12 (continued).

| Depth in metres .....          | 0     | 10    | 20    | 32    |
|--------------------------------|-------|-------|-------|-------|
| Coscosira polychorda .....     | ..    | ..    | ..    | 800   |
| Melosira italica .....         | ..    | ..    | 200   | ..    |
| — sulcata .....                | ..    | ..    | ..    | 2,700 |
| Nitzschia closterium .....     | 1,800 | 2,300 | 1,500 | 400   |
| — delicatissima .....          | 100   | 200   | 400   | 1,200 |
| — seriata .....                | ..    | 3,100 | 1,500 | ..    |
| Pleurosigma aestuarii .....    | 100   | ..    | ..    | ..    |
| Rhizosolenia hebet. f. semisp. | 100   | ..    | 200   | 1,300 |
| — imbricata var. Shrubsolei    | ..    | ..    | ..    | 100   |
| Skeletonema costatum .....     | ..    | 200   | ..    | 1,300 |
| Thalassionema nitzschioides.   | 300   | 400   | 300   | 300   |
| Thalassiosira decipiens .....  | 600   | 600   | 700   | 1,000 |
| Pennate bottom diatoms .....   | 5,000 | 8,000 | 1,000 | 3,500 |
| Dinoflagellates:               |       |       |       |       |
| Glenodinium lenticula f.       |       |       |       |       |
| asymmetrica .....              | ..    | ..    | ..    | 100   |
| Goniaulax spinifera .....      | ..    | 100   | ..    | ..    |
| Gymnodiniaceae .....           | 100   | 2,200 | 1,400 | 900   |
| Peridinium depressum .....     | ..    | 100   | ..    | ..    |
| — globulus var. ovatum ..      | 300   | 200   | 200   | 200   |
| — pellucidum .....             | ..    | ..    | ..    | 200   |
| — trochoideum .....            | 900   | ..    | 200   | 100   |

## Other flagellates, etc.:

|                                                 |       |       |       |       |
|-------------------------------------------------|-------|-------|-------|-------|
| Bodo marina .....                               | 2,500 | 1,000 | 1,500 | 5,500 |
| Carteria sp. ....                               | 3,000 | 1,000 | 500   | ..    |
| Monosiga marina .....                           | 6,500 | 5,500 | 6,000 | 1,000 |
| Phaeocystis sp. ....                            | ..    | rr    | ..    | rr    |
| Pterosperma cristatum .....                     | 100   | ..    | ..    | ..    |
| Monades and flagellates not<br>classified ..... | 6,500 | 2,000 | 7,500 | 3,500 |

## Ciliates:

|                              |     |     |     |     |
|------------------------------|-----|-----|-----|-----|
| Laboea conica .....          | ..  | 100 | ..  | 100 |
| — vestita .....              | 100 | ..  | 100 | 100 |
| Lohmanniella oviformis ..... | 200 | ..  | 100 | 100 |
| Mesodinium rubrum .....      | 300 | 900 | ..  | 100 |
| Ptychocylis urnula .....     | ..  | 300 | ..  | ..  |
| Tintinnopsis beroidea .....  | 100 | ..  | ..  | ..  |

Table 13.

St. 6572, Sect. R. Lat.: 55°23' N., Long.: 1°27' W.  
Plankton per litre. 20/5-47.

| Depth in metres                             | 0      | 10     | 20     | 40     |
|---------------------------------------------|--------|--------|--------|--------|
| Temperature, °C.....                        | 8.37   | 7.20   | 6.70   | 6.40   |
| Salinity, per mille.....                    | 34.30  | 34.35  | 34.35  | 34.37  |
| $\sigma_t$ .....                            | 26.68  | 26.90  | 26.97  | 27.03  |
| P, $\mu\text{g-atom/L}$ .....               | 0.15   | ..     | 0.15   | 0.20   |
| $\text{NNO}_3$ , $\mu\text{g-atom/L}$ ..... | 4.5    | ..     | 6.0    | 6.0    |
| $\text{O}_2$ , ml/L.....                    | 6.94   | ..     | ..     | 6.83   |
| $\text{O}_2$ , % of saturation.....         | 105.8  | ..     | ..     | 99.8   |
| Number of ml examined.....                  | 2 & 10 | 2 & 10 | 2 & 10 | 2 & 10 |

## Diatoms:

|                                      |     |       |        |        |
|--------------------------------------|-----|-------|--------|--------|
| <i>Actinoptychus undulatus</i> ...   | ..  | ..    | ..     | 200    |
| <i>Asterionella japonica</i> .....   | ..  | 2,200 | 46,100 | 47,500 |
| <i>Chaetoceros cinctus</i> .....     | ..  | ..    | 300    | 200    |
| — <i>compressus</i> .....            | ..  | ..    | 1,500  | 800    |
| — <i>curvisetus</i> .....            | ..  | ..    | ..     | 200    |
| — <i>debilis</i> .....               | ..  | ..    | 100    | 100    |
| — <i>subsecundus</i> .....           | ..  | ..    | 200    | ..     |
| <i>Ditylum Brightwelli</i> .....     | ..  | ..    | ..     | 200    |
| <i>Melosira sulcata</i> .....        | ..  | 1,000 | 4,400  | 7,500  |
| <i>Nitzschia closterium</i> .....    | ..  | 200   | 1,300  | 1,000  |
| — <i>delicatissima</i> .....         | ..  | ..    | 1,200  | 1,500  |
| — <i>seriata</i> .....               | ..  | ..    | 100    | ..     |
| <i>Pleurosigma angulatum</i> ....    | ..  | ..    | 500    | ..     |
| <i>Podosira stelliger</i> .....      | ..  | ..    | 100    | ..     |
| <i>Skeletonema costatum</i> .....    | ..  | 4,800 | 49,000 | 6,900  |
| <i>Thalassionema nitzschioides</i> . | ..  | ..    | 1,000  | 5,900  |
| <i>Thalassiosira decipiens</i> ..... | ..  | ..    | 6,200  | 5,800  |
| Pennate bottom diatoms...            | 500 | 500   | 4,500  | 7,500  |

## Dinoflagellates:

|                                                     |     |    |     |    |
|-----------------------------------------------------|-----|----|-----|----|
| <i>Exuviaella baltica</i> .....                     | 500 | .. | ..  | .. |
| <i>Peridinium globulus</i> var. <i>ovatum</i> ..... | ..  | .. | 100 | .. |

## Other flagellates, etc.:

|                                             |       |       |       |       |
|---------------------------------------------|-------|-------|-------|-------|
| <i>Bodo marina</i> .....                    | 1,000 | 2,500 | 2,000 | 1,000 |
| Flagellates and monades not classified..... | 8,000 | 2,000 | 2,500 | 2,000 |

## Ciliates:

|                                    |     |     |     |     |
|------------------------------------|-----|-----|-----|-----|
| <i>Laboea conica</i> .....         | 400 | ..  | ..  | ..  |
| — <i>vestita</i> .....             | 200 | 100 | ..  | ..  |
| <i>Lohmanniella oviformis</i> .... | ..  | ..  | 200 | 800 |
| <i>Mesodinium rubrum</i> .....     | ..  | 100 | 100 | ..  |
| <i>Tintinnopsis beroidea</i> ..... | ..  | ..  | ..  | 300 |

Table 14.

St. 6566, Sect. R. Lat.: 55°23' N., Long.: 0°14' E.  
Plankton per litre. 20/5-47.

| Depth in metres                             | 0      | 10     | 20     | 50     |
|---------------------------------------------|--------|--------|--------|--------|
| Temperature, °C.....                        | 8.13   | 8.09   | 6.28   | 4.20   |
| Salinity, per mille.....                    | 34.66  | 34.67  | 34.76  | 34.80  |
| $\sigma_t$ .....                            | 27.00  | 27.02  | 27.34  | 27.63  |
| P, $\mu\text{g-atom/L}$ .....               | 0.15   | ..     | ..     | ..     |
| $\text{NNO}_3$ , $\mu\text{g-atom/L}$ ..... | 4.0    | ..     | ..     | ..     |
| $\text{O}_2$ , ml/L.....                    | 7.06   | ..     | ..     | ..     |
| $\text{O}_2$ , % of saturation.....         | 107.5  | ..     | ..     | ..     |
| Number of ml examined.....                  | 2 & 10 | 2 & 10 | 2 & 10 | 2 & 10 |

## Diatoms:

|                                               |     |     |        |        |
|-----------------------------------------------|-----|-----|--------|--------|
| <i>Asterionella japonica</i> .....            | ..  | ..  | ..     | 2,100  |
| <i>Chaetoceros affinis</i> var. <i>Willei</i> | ..  | ..  | 21,700 | ..     |
| — <i>cinctus</i> .....                        | ..  | ..  | ..     | 7,300  |
| — <i>compressus</i> .....                     | ..  | ..  | ..     | 51,400 |
| — <i>debilis</i> .....                        | ..  | ..  | ..     | 3,300  |
| — <i>densus</i> .....                         | 400 | ..  | ..     | ..     |
| — <i>subsecundus</i> .....                    | ..  | ..  | ..     | 3,000  |
| — <i>sp.</i> .....                            | 300 | 500 | ..     | ..     |
| <i>Coscinodiscus centralis</i> .....          | ..  | 100 | ..     | ..     |
| — <i>radiatus</i> .....                       | ..  | ..  | ..     | 100    |
| <i>Melosira sulcata</i> .....                 | 100 | 100 | ..     | 2,400  |
| <i>Nitzschia closterium</i> .....             | ..  | ..  | 5,000  | 300    |
| — <i>delicatissima</i> .....                  | ..  | 400 | 700    | 3,600  |
| — <i>seriata</i> .....                        | ..  | ..  | 200    | ..     |
| <i>Rhizosolenia fragilissima</i> ...          | ..  | ..  | 3,600  | ..     |
| <i>Skeletonema costatum</i> .....             | ..  | ..  | ..     | 7,300  |
| <i>Thalassionema nitzschioides</i> .          | 300 | ..  | ..     | 200    |
| <i>Thalassiosira decipiens</i> .....          | ..  | 100 | ..     | 1,900  |
| — <i>Nordenskjoeldi</i> .....                 | ..  | ..  | ..     | 200    |
| Pennate bottom diatoms...                     | ..  | 500 | 500    | 3,500  |

## Dinoflagellates:

|                                   |       |       |     |     |
|-----------------------------------|-------|-------|-----|-----|
| <i>Ceratium lineatum</i> .....    | 100   | ..    | ..  | 100 |
| — <i>tripos</i> .....             | ..    | 100   | ..  | ..  |
| <i>Exuviaella baltica</i> .....   | 300   | ..    | ..  | ..  |
| <i>Gymnodiniaceae</i> .....       | 3,500 | 5,500 | ..  | ..  |
| <i>Peridinium depressum</i> ..... | ..    | ..    | 200 | 200 |
| — <i>trochoideum</i> .....        | 1,200 | 1,500 | 100 | ..  |

## Other flagellates, etc.:

|                                             |        |        |        |       |
|---------------------------------------------|--------|--------|--------|-------|
| <i>Bodo marina</i> .....                    | 4,500  | 6,000  | 2,000  | 1,000 |
| <i>Carteria</i> sp.....                     | 1,500  | 2,500  | 2,500  | ..    |
| <i>Monosiga marina</i> .....                | 53,000 | 32,500 | 16,500 | 3,500 |
| <i>Phaeocystis</i> sp.....                  | ..     | ..     | ..     | r     |
| Flagellates and monades not classified..... | 5,000  | 2,500  | 1,500  | 1,500 |

## Ciliates:

|                                |     |     |     |     |
|--------------------------------|-----|-----|-----|-----|
| <i>Didinium parvulum</i> ..... | ..  | ..  | ..  | 100 |
| <i>Laboea conica</i> .....     | 200 | 200 | 100 | ..  |
| — <i>crassula</i> .....        | 100 | 200 | ..  | ..  |
| — <i>strobila</i> .....        | ..  | 500 | 300 | ..  |

Table 14 (continued).

| Depth in metres .....              | 0   | 10  | 20  | 50  |
|------------------------------------|-----|-----|-----|-----|
| <i>Laboea vestita</i> .....        | 200 | 200 | 200 | ..  |
| — sp.....                          | ..  | ..  | 100 | 400 |
| <i>Lohmanniella oviformis</i> .... | 100 | 100 | 800 | 100 |
| <i>Mesodinium rubrum</i> .....     | 600 | 400 | ..  | ..  |

Table 15.

St. 6560, Sect. R. Lat.: 55°23' N., Long.: 1°59.5' E.  
Plankton per litre. 19/5-47.

| Depth in metres .....                  | 0      | 10     | 20     | 46     |
|----------------------------------------|--------|--------|--------|--------|
| Temperature, °C.....                   | 9.42   | 7.27   | 5.06   | 4.37   |
| Salinity, per mille.....               | 34.80  | 34.80  | 34.78  | 34.81  |
| <i>σ<sub>t</sub></i> .....             | 26.92  | 27.25  | 27.51  | 27.61  |
| P, µg-atom/L .....                     | 0.1    | ..     | 0.15   | 0.2    |
| NO <sub>3</sub> , µg-atom/L.....       | 2.5    | ..     | 3.0    | 3.0    |
| O <sub>2</sub> , ml/L .....            | 6.93   | ..     | ..     | 6.96   |
| O <sub>2</sub> , % of saturation ..... | 108.3  | ..     | ..     | 97.3   |
| Number of ml examined.....             | 2 & 10 | 2 & 10 | 2 & 10 | 2 & 10 |

## Diatoms:

|                                              |     |       |       |        |
|----------------------------------------------|-----|-------|-------|--------|
| <i>Biddulphia aurita</i> .....               | ..  | 200   | ..    | ..     |
| <i>Chaetoceros compressus</i> ....           | ..  | ..    | ..    | 9,200  |
| — <i>curvisetus</i> .....                    | ..  | ..    | 500   | ..     |
| — <i>debilis</i> .....                       | ..  | ..    | ..    | 600    |
| — <i>densus</i> .....                        | ..  | ..    | 300   | ..     |
| — <i>subsecundus</i> .....                   | ..  | ..    | ..    | 700    |
| — sp.....                                    | ..  | 200   | ..    | 1,800  |
| <i>Coscinodiscus concinnus</i> ....          | 200 | ..    | ..    | 200    |
| — <i>oculus iridis</i> .....                 | ..  | ..    | ..    | 100    |
| <i>Melosira sulcata</i> .....                | ..  | 100   | ..    | 200    |
| <i>Nitzschia closterium</i> .....            | ..  | ..    | ..    | 500    |
| — <i>delicatissima</i> .....                 | ..  | ..    | 100   | 1,000  |
| — sp.....                                    | ..  | ..    | ..    | 800    |
| <i>Rhizosolenia alata</i> .....              | ..  | 100   | 7,000 | ..     |
| — <i>imbricata</i> var. <i>Shrubsolei</i> .. | ..  | ..    | 100   | ..     |
| <i>Skeletonema costatum</i> .....            | ..  | 2,000 | ..    | 2,500  |
| <i>Thalassiosira gravida</i> .....           | ..  | ..    | ..    | 11,100 |
| — <i>Nordenskjoeldi</i> .....                | ..  | ..    | ..    | 900    |
| Pennate bottom diatoms...                    | ..  | 500   | 1,500 | 2,000  |

## Dinoflagellates:

|                                                |       |       |     |       |
|------------------------------------------------|-------|-------|-----|-------|
| <i>Ceratium longipes</i> .....                 | ..    | 200   | ..  | ..    |
| <i>Dinophysis debiliior</i> .....              | ..    | ..    | 300 | ..    |
| Gymnodiniaceae.....                            | 1,300 | 1,100 | ..  | 5,000 |
| <i>Peridinium globulus</i> var. <i>ovata</i> . | 100   | ..    | ..  | 100   |
| <i>Porella perforata</i> .....                 | 1,000 | ..    | 100 | ..    |

## Other flagellates, etc.:

|                              |        |       |       |       |
|------------------------------|--------|-------|-------|-------|
| <i>Bodo marina</i> .....     | 14,500 | 5,000 | 2,000 | 2,000 |
| <i>Monosiga marina</i> ..... | 4,500  | 8,000 | 2,000 | 500   |

Table 15 (continued).

| Depth in metres .....                       | 0       | 10      | 20      | 46     |
|---------------------------------------------|---------|---------|---------|--------|
| Flagellates and monades not classified..... | 152,500 | 132,000 | 127,500 | 70,000 |
| Ciliates:                                   |         |         |         |        |
| <i>Laboea strobila</i> .....                | ..      | ..      | 200     | ..     |
| — <i>vestita</i> .....                      | ..      | 800     | ..      | ..     |
| — sp.....                                   | ..      | 1,800   | ..      | ..     |
| <i>Lohmanniella oviformis</i> ....          | 1,200   | ..      | ..      | 400    |
| <i>Mesodinium rubrum</i> .....              | ..      | ..      | 500     | 200    |
| <i>Tintinnopsis beroidea</i> .....          | ..      | 100     | ..      | 100    |
| <i>Woodania conicoides</i> .....            | ..      | ..      | 900     | 500    |

Table 16.

St. 6554, Sect. R. Lat.: 55°23' N., Long.: 3°42' E.  
Plankton per litre. 19/5-47.

| Depth in metres .....                  | 0      | 10     | 20     | 27     |
|----------------------------------------|--------|--------|--------|--------|
| Temperature, °C.....                   | 8.04   | 7.82   | 6.77   | 6.23   |
| Salinity, per mille.....               | 34.67  | 34.70  | 34.70  | 34.69  |
| <i>σ<sub>t</sub></i> .....             | 27.02  | 27.08  | 27.23  | 27.30  |
| P, µg-atom/L .....                     | 0.1    | ..     | ..     | 0.2    |
| NO <sub>3</sub> , µg-atom/L.....       | 2.5    | ..     | ..     | 2.5    |
| O <sub>2</sub> , ml/L .....            | 6.96   | ..     | ..     | 6.82   |
| O <sub>2</sub> , % of saturation ..... | 105.5  | ..     | ..     | 99.4   |
| Number of ml examined.....             | 2 & 10 | 2 & 10 | 2 & 10 | 2 & 10 |

## Diatoms:

|                                      |     |       |        |       |
|--------------------------------------|-----|-------|--------|-------|
| <i>Achnanthes</i> sp.....            | ..  | 2,000 | ..     | ..    |
| <i>Asterionella japonica</i> .....   | ..  | ..    | ..     | 400   |
| — <i>kariana</i> .....               | ..  | ..    | 100    | ..    |
| <i>Biddulphia sinensis</i> .....     | ..  | ..    | ..     | 100   |
| <i>Chaetoceros cinctus</i> .....     | ..  | ..    | 200    | ..    |
| — <i>compressus</i> .....            | ..  | ..    | 400    | ..    |
| — <i>decipiens</i> .....             | ..  | ..    | 4,100  | ..    |
| — <i>subsecundus</i> .....           | ..  | ..    | 1,000  | 300   |
| — sp.....                            | ..  | ..    | ..     | 500   |
| <i>Coscinodiscus radiatus</i> ....   | ..  | ..    | 200    | ..    |
| <i>Melosira sulcata</i> .....        | ..  | ..    | ..     | 500   |
| <i>Nitzschia closterium</i> .....    | ..  | ..    | 500    | 300   |
| — <i>seriata</i> .....               | ..  | ..    | 24,000 | ..    |
| <i>Rhizosolenia alata</i> .....      | 700 | ..    | 100    | ..    |
| <i>Skeletonema costatum</i> .....    | 400 | ..    | 1,300  | 1,900 |
| <i>Thalassiosira decipiens</i> ..... | ..  | ..    | 1,200  | 200   |
| — <i>gravida</i> .....               | ..  | ..    | 100    | ..    |
| — sp.....                            | ..  | ..    | 900    | 700   |
| Pennate bottom diatoms...            | 500 | 500   | 1,500  | 3,000 |

## Dinoflagellates:

|                                    |       |        |       |       |
|------------------------------------|-------|--------|-------|-------|
| <i>Ceratium tripos</i> .....       | 100   | ..     | ..    | ..    |
| Gymnodiniaceae.....                | ..    | 10,500 | 2,000 | 1,500 |
| <i>Peridinium trochoideum</i> .... | 1,500 | 2,000  | ..    | ..    |
| Cysts of dinoflagellates....       | 1,500 | ..     | ..    | ..    |

Table 16 (continued).

| Depth in metres                       | 0      | 10     | 20     | 27     |
|---------------------------------------|--------|--------|--------|--------|
| Other flagellates, etc.:              |        |        |        |        |
| Bodo marina                           | 2,500  | 12,000 | 4,000  | 2,500  |
| Carteria sp.                          | 4,000  | 9,000  | 2,500  | 20,000 |
| Monosiga marina                       | ..     | 1,000  | ..     | ..     |
| Phaeocystis sp.                       | rr     | ..     | ..     | ..     |
| Flagellates and monads not classified | 33,000 | 52,000 | 20,500 | 28,000 |
| Ciliates:                             |        |        |        |        |
| Laboea crassula                       | ..     | ..     | ..     | 100    |
| — vestita                             | 100    | ..     | ..     | ..     |
| — sp.                                 | ..     | ..     | 100    | 100    |
| Lohmanniella oviformis                | ..     | ..     | 100    | 100    |
| Tintinnopsis beroidea                 | ..     | ..     | 100    | 100    |

Table 17.

St. 6547, Sect. R. Lat.: 55°23' N., Long.: 6°43' E.  
Plankton per litre, 1954-57.

| Depth in metres                  | 0      | 10     | 20     | 29     |
|----------------------------------|--------|--------|--------|--------|
| Temperature, °C.                 | 8.90   | 6.95   | 4.01   | 3.79   |
| Salinity, per mille              | 33.04  | 33.66  | 34.04  | 34.14  |
| σ <sub>t</sub>                   | 25.62  | 26.40  | 27.04  | 27.14  |
| P, μg-atom/L                     | 0.0    | ..     | ..     | 0.15   |
| NNO <sub>3</sub> , μg-atom/L     | 2.5    | ..     | ..     | 5.0    |
| O <sub>2</sub> , ml/L            | 7.50   | ..     | ..     | 7.13   |
| O <sub>2</sub> , % of saturation | 114.8  | ..     | ..     | 97.8   |
| Number of ml examined            | 2 & 10 | 2 & 10 | 2 & 10 | 2 & 10 |

## Diatoms:

|                         |         |           |        |       |
|-------------------------|---------|-----------|--------|-------|
| Actinoptychus undulatus | ..      | ..        | 100    | 100   |
| Asterionella japonica   | ..      | ..        | 1,000  | ..    |
| Biddulphia aurita       | ..      | ..        | 1,300  | 900   |
| — sinensis              | ..      | ..        | ..     | 100   |
| Chaetoceros affinis     | 42,000  | 18,000    | 15,700 | 500   |
| — borealis              | ..      | ..        | 100    | ..    |
| — compressus            | ..      | ..        | 600    | 200   |
| — constrictus           | ..      | ..        | ..     | 800   |
| — curvisetus            | ..      | ..        | 4,300  | 600   |
| — debilis               | ..      | ..        | 1,500  | 2,400 |
| — decipiens             | ..      | ..        | 700    | ..    |
| — densus                | ..      | ..        | 500    | ..    |
| — didymus               | ..      | ..        | 900    | 200   |
| — laciniosus            | ..      | ..        | 200    | ..    |
| Coscinodiscus concinnus | ..      | ..        | ..     | 300   |
| Eucampia zoodiacus      | ..      | ..        | 100    | ..    |
| Melosira sulcata        | ..      | 2,000     | ..     | ..    |
| Nitzschia closterium    | 698,000 | 1,097,000 | 8,000  | 3,000 |
| — delicatissima         | 200     | ..        | ..     | 200   |
| — seriata               | ..      | 200       | ..     | ..    |

Table 17 (continued).

| Depth in metres                       | 0       | 10      | 20     | 29    |
|---------------------------------------|---------|---------|--------|-------|
| Rhizosolenia alata                    |         |         |        |       |
| — hebetata f. semispina               | ..      | ..      | 12,000 | 600   |
| — imbricata var. Shrubsolei           | ..      | ..      | 200    | ..    |
| Skeletonema costatum                  | ..      | ..      | 15,500 | 8,700 |
| Thalassionema nitzschioides           | ..      | 100     | 2,300  | 2,700 |
| Thalassiosira decipiens               | ..      | ..      | 300    | ..    |
| Pennate bottom diatoms                | ..      | 1,000   | 2,000  | 4,000 |
| Dinoflagellates:                      |         |         |        |       |
| Ceratium furca                        | ..      | ..      | ..     | 100   |
| — fusus                               | ..      | ..      | 300    | ..    |
| — lineatum                            | ..      | ..      | 100    | 100   |
| — longipes                            | 100     | 100     | 200    | 200   |
| — macroceros                          | ..      | ..      | 900    | ..    |
| — tripos                              | ..      | ..      | 1,900  | 100   |
| — sp.                                 | ..      | ..      | 100    | ..    |
| Dinophysis acuta                      | 100     | 200     | ..     | ..    |
| Glenodinium lenticula f. asymmetrica  | 100     | 100     | ..     | ..    |
| Goniaulax triacantha                  | 200     | ..      | ..     | ..    |
| Gymnodinium sp.                       | ..      | 1,000   | 700    | 100   |
| Peridinium brevipes                   | ..      | ..      | 100    | ..    |
| — depressum                           | ..      | 100     | 200    | ..    |
| — globulus var. ovatum                | 1,100   | 400     | ..     | 100   |
| — pallidum                            | ..      | ..      | 100    | ..    |
| — trochoideum                         | 39,000  | 4,200   | 1,000  | ..    |
| Phalacroma rotundatum                 | ..      | 300     | ..     | ..    |
| Protoceratium reticulatum             | 300     | 200     | ..     | 100   |
| Other flagellates, etc.:              |         |         |        |       |
| Carteria sp.                          | 11,000  | 27,000  | ..     | ..    |
| Monosiga marina                       | 104,000 | 142,000 | 12,000 | 4,000 |
| Phaeocystis sp.                       | ..      | ..      | c      | +     |
| Flagellates and monads not classified | 17,000  | 93,000  | 3,000  | ..    |
| Ciliates:                             |         |         |        |       |
| Laboea conica                         | ..      | 900     | 200    | ..    |
| — strobila                            | ..      | 200     | ..     | ..    |
| — sp.                                 | 100     | 1,400   | 500    | 100   |
| Lohmanniella oviformis                | 100     | 500     | 3,900  | 2,900 |
| Mesodinium rubrum                     | ..      | 2,800   | 2,500  | 1,100 |
| Tintinnopsis beroidea                 | 2,700   | 900     | 200    | ..    |

Table 18.

St. 6573, Sect. Q. Lat.: 56°30' N., Long.: 2°23' W.  
Plankton per litre. 20/5-47.

| Depth in metres                               | 0      | 10     | 20     | 42     |
|-----------------------------------------------|--------|--------|--------|--------|
| Temperature, °C.....                          | 9.12   | 6.80   | 5.90   | 5.58   |
| Salinity, per mille.....                      | 33.48  | 34.14  | 34.31  | 34.37  |
| $\sigma_t$ .....                              | 25.93  | 26.79  | 27.04  | 27.13  |
| P, $\mu\text{g-atom/L}$ .....                 | 0.0    | ..     | 0.2    | 0.2    |
| NNO <sub>3</sub> , $\mu\text{g-atom/L}$ ..... | 0.8    | ..     | 4.5    | 5.5    |
| O <sub>2</sub> , ml/L.....                    | 7.90   | ..     | ..     | 6.99   |
| O <sub>2</sub> , % of saturation.....         | 121.7  | ..     | ..     | 100.2  |
| Number of ml examined.....                    | 2 & 10 | 2 & 10 | 2 & 10 | 2 & 10 |

## Diatoms:

|                                       |         |        |        |        |
|---------------------------------------|---------|--------|--------|--------|
| <i>Actinopterychus undulatus</i> ...  | ..      | ..     | ..     | 400    |
| <i>Asterionella japonica</i> .....    | 707,200 | 12,800 | 6,600  | 8,700  |
| <i>Biddulphia regia</i> .....         | ..      | ..     | ..     | 100    |
| <i>Cerataulina Bergoni</i> .....      | 300     | ..     | ..     | ..     |
| <i>Chaetoceros affinis</i> .....      | 10,500  | ..     | ..     | ..     |
| — <i>cinctus</i> .....                | 51,200  | 700    | 200    | 800    |
| — <i>compressus</i> .....             | 51,100  | 1,100  | 500    | 500    |
| — <i>convolutus</i> .....             | 500     | ..     | ..     | ..     |
| — <i>crinitus</i> ?.....              | 1,200   | ..     | ..     | ..     |
| — <i>curvisetus</i> .....             | 4,800   | ..     | ..     | ..     |
| — <i>danicus</i> .....                | 800     | ..     | ..     | ..     |
| — <i>debilis</i> .....                | 7,100   | 500    | 100    | ..     |
| — <i>septentrionalis</i> .....        | 2,500   | ..     | ..     | ..     |
| — <i>subsecundus</i> .....            | ..      | ..     | ..     | 200    |
| — <i>sp.</i> .....                    | 1,700   | ..     | 800    | ..     |
| <i>Coscinodiscus excentricus</i> ...  | ..      | ..     | ..     | 100    |
| <i>Cymatosira belgica</i> .....       | ..      | ..     | 500    | ..     |
| <i>Leptocylindrus danicus</i> .....   | 600     | ..     | ..     | ..     |
| — <i>minimus</i> .....                | 2,200   | 300    | 500    | ..     |
| <i>Melosira sulcata</i> .....         | ..      | 400    | 1,700  | 14,000 |
| <i>Navicula distans</i> .....         | ..      | ..     | 200    | 300    |
| <i>Nitzschia closterium</i> .....     | 10,100  | 3,300  | 14,700 | 4,500  |
| — <i>delicatissima</i> .....          | 80,600  | 2,200  | 3,300  | 2,100  |
| — <i>seriata</i> .....                | 2,000   | ..     | 800    | ..     |
| <i>Pleurosigma angulatum</i> .....    | ..      | ..     | ..     | 100    |
| — <i>fasciola</i> .....               | 100     | 100    | ..     | 300    |
| — <i>sp.</i> .....                    | ..      | ..     | ..     | 100    |
| <i>Podosira stelliger</i> .....       | ..      | ..     | ..     | 200    |
| <i>Rhaphoneis amphiceros</i> .....    | ..      | ..     | 100    | 100    |
| — <i>surirella</i> .....              | ..      | ..     | ..     | 300    |
| <i>Rhizosolenia hebet. f. semisp.</i> | ..      | ..     | 400    | 400    |
| <i>Skeletonema costatum</i> .....     | 734,400 | 14,100 | 27,800 | 42,700 |
| <i>Thalassionema nitzschioides</i>    | 500     | 1,800  | 4,400  | 15,900 |
| <i>Thalassiosira decipiens</i> .....  | 14,800  | 1,900  | 3,500  | 7,900  |
| — <i>gravida</i> .....                | 900     | ..     | ..     | ..     |
| — <i>Nordenskjoldi</i> .....          | ..      | 300    | 200    | 1,500  |
| Pennate bottom diatoms...             | 1,500   | 2,000  | 7,500  | 14,300 |

## Dinoflagellates:

|                                   |    |     |    |     |
|-----------------------------------|----|-----|----|-----|
| <i>Amphidinium sphenoides</i> ... | .. | ..  | .. | 200 |
| <i>Ceratium tripos</i> .....      | .. | 100 | .. | ..  |

Table 18 (continued).

| Depth in metres                  | 0     | 10    | 20  | 42  |
|----------------------------------|-------|-------|-----|-----|
| <i>Exuviaella baltica</i> .....  | 1,100 | 300   | ..  | ..  |
| <i>Gymnodinium Lohmanni</i> ...  | ..    | 400   | ..  | ..  |
| <i>Gymnodiniaceae</i> .....      | ..    | ..    | 500 | ..  |
| <i>Peridinium brevipes</i> ..... | 100   | ..    | ..  | 100 |
| — <i>crassipes</i> .....         | ..    | ..    | ..  | 100 |
| — <i>globulus var. ovatum</i> .. | ..    | ..    | ..  | 100 |
| — <i>trochoideum</i> .....       | 1,700 | 2,500 | 500 | 500 |
| — <i>sp.</i> .....               | ..    | ..    | 100 | ..  |
| Cysts of dinoflagellates....     | 600   | ..    | ..  | ..  |

## Other flagellates, etc.:

|                                            |        |        |        |        |
|--------------------------------------------|--------|--------|--------|--------|
| <i>Bodo marina</i> .....                   | 1,000  | 500    | 300    | 500    |
| <i>Carteria sp.</i> .....                  | 8,000  | 2,000  | 3,500  | ..     |
| <i>Monosiga marina</i> .....               | ..     | 2,500  | 2,500  | ..     |
| Monads and flagellates not classified..... | 53,000 | 54,000 | 37,000 | 11,500 |

## Ciliates:

|                                    |     |     |       |     |
|------------------------------------|-----|-----|-------|-----|
| <i>Laboea conica</i> .....         | ..  | ..  | 100   | ..  |
| — <i>strobila</i> .....            | ..  | 100 | ..    | ..  |
| — <i>vestita</i> .....             | ..  | ..  | 300   | 300 |
| — <i>sp.</i> .....                 | ..  | 100 | ..    | ..  |
| <i>Lohmanniella oviformis</i> .... | ..  | 200 | ..    | 200 |
| <i>Mesodinium rubrum</i> .....     | ..  | 600 | 1,200 | 200 |
| <i>Metacylis mediterranea</i> .... | ..  | ..  | ..    | 100 |
| <i>Tintinnopsis beroidea</i> ..... | 200 | ..  | ..    | 100 |

Table 19.

St. 6583, Sect. Q. Lat.: 56°30' N., Long.: 0°34' E.  
Plankton per litre. 21/5-47.

| Depth in metres                               | 0 <sup>1)</sup> | 10     | 20     | 50     |
|-----------------------------------------------|-----------------|--------|--------|--------|
| Temperature, °C.....                          | 7.94            | 7.42   | 6.40   | 5.58   |
| Salinity, per mille.....                      | 35.05           | 35.05  | 35.08  | 35.12  |
| $\sigma_t$ .....                              | 27.35           | 27.42  | 27.58  | 27.72  |
| P, $\mu\text{g-atom/L}$ .....                 | 0.0             | ..     | ..     | ..     |
| NNO <sub>3</sub> , $\mu\text{g-atom/L}$ ..... | 3.0             | ..     | ..     | ..     |
| O <sub>2</sub> , ml/L.....                    | 7.22            | ..     | ..     | ..     |
| O <sub>2</sub> , % of saturation.....         | 109.7           | ..     | ..     | ..     |
| Number of ml examined.....                    | 2 & 10          | 2 & 10 | 2 & 10 | 2 & 10 |

## Diatoms:

|                                    |    |     |     |       |
|------------------------------------|----|-----|-----|-------|
| <i>Asterionella japonica</i> ..... | .. | ..  | ..  | 100   |
| <i>Cerataulina Bergoni</i> .....   | .. | ..  | ..  | 200   |
| <i>Chaetoceros borealis</i> .....  | .. | ..  | ..  | 100   |
| — <i>compressus</i> .....          | .. | ..  | ..  | 2,000 |
| — <i>debilis</i> .....             | .. | ..  | 100 | ..    |
| — <i>densus</i> .....              | .. | ..  | ..  | 1,300 |
| — <i>sp.</i> .....                 | .. | ..  | ..  | 200   |
| <i>Dactyliosolen mediterraneus</i> | .. | 100 | ..  | ..    |
| <i>Melosira sulcata</i> .....      | .. | ..  | 100 | 1,100 |

<sup>1)</sup> The Plankton sample lost.

Table 19 (continued).

| Depth in metres .....                        | 0  | 10     | 20      | 50     |
|----------------------------------------------|----|--------|---------|--------|
| <i>Navicula distans</i> .....                | .. | ..     | ..      | 200    |
| — sp. ....                                   | .. | ..     | 100     | ..     |
| <i>Nitzschia closterium</i> .....            | .. | 100    | ..      | 900    |
| — <i>delicatissima</i> .....                 | .. | 1,200  | ..      | 5,000  |
| <i>Pleurosigma</i> sp. ....                  | .. | ..     | ..      | 100    |
| <i>Skeletonema costatum</i> .....            | .. | ..     | ..      | 800    |
| <i>Thalassionema nitzschioides</i> ..        | .. | ..     | ..      | 1,500  |
| <i>Thalassiosira decipiens</i> .....         | .. | ..     | ..      | 800    |
| Pennate bottom diatoms ...                   | .. | 500    | 500     | 1,500  |
| Dinoflagellates:                             |    |        |         |        |
| <i>Gymnodinium Lohmanni</i> ...              | .. | 100    | 200     | ..     |
| Gymnodiniaceae .....                         | .. | 300    | 400     | 600    |
| <i>Peridinium brevipes</i> .....             | .. | 100    | ..      | ..     |
| — <i>globulus</i> var. <i>ovatum</i> ..      | .. | ..     | ..      | 100    |
| — <i>trochoideum</i> .....                   | .. | 100    | 300     | ..     |
| Cysts of dinoflagellates .....               | .. | ..     | ..      | 100    |
| Other flagellates, etc.:                     |    |        |         |        |
| <i>Bodo marina</i> .....                     | .. | 2,000  | 600     | 200    |
| <i>Carteria</i> sp. ....                     | .. | 5,000  | ..      | ..     |
| <i>Distephanus speculum</i> .....            | .. | ..     | 100     | ..     |
| <i>Monosiga marina</i> .....                 | .. | 13,000 | 141,500 | 17,500 |
| <i>Pterosperma cristatum</i> .....           | .. | ..     | ..      | 100    |
| Monades and flagellates not classified ..... | .. | 45,000 | 35,000  | 14,500 |
| Ciliates:                                    |    |        |         |        |
| <i>Laboea conica</i> .....                   | .. | 100    | ..      | ..     |
| — <i>strobila</i> .....                      | .. | 200    | ..      | 100    |
| — <i>vestita</i> .....                       | .. | 100    | 300     | ..     |
| <i>Lohmanniella oviformis</i> .....          | .. | ..     | ..      | 1,400  |
| Ciliates not identified .....                | .. | 100    | ..      | ..     |

Table 20.

St. 6593, Sect. Q. Lat.: 56°30' N., Long.: 3°29' E.  
Plankton per litre. 21/5-47.

| Depth in metres .....                         | 0      | 10     | 20     | 50     |
|-----------------------------------------------|--------|--------|--------|--------|
| Temperature, °C. ....                         | 8.00   | 6.87   | 3.97   | 3.19   |
| Salinity, per mille .....                     | 34.69  | 34.69  | 34.74  | 34.74  |
| $\sigma_t$ .....                              | 27.05  | 27.22  | 27.60  | 27.68  |
| P, $\mu\text{g-atom/L}$ .....                 | 0.0    | ..     | ..     | ..     |
| NNO <sub>3</sub> , $\mu\text{g-atom/L}$ ..... | 4.0    | ..     | ..     | ..     |
| O <sub>2</sub> , ml/L .....                   | 7.66   | ..     | ..     | ..     |
| O <sub>2</sub> , % of saturation .....        | 116.2  | ..     | ..     | ..     |
| Number of ml examined .....                   | 2 & 10 | 2 & 10 | 2 & 10 | 2 & 10 |

## Diatoms:

|                                     |    |     |    |     |
|-------------------------------------|----|-----|----|-----|
| <i>Actinoptychus undulatus</i> ...  | .. | ..  | .. | 100 |
| <i>Chaetoceros compressus</i> ..... | .. | 100 | .. | ..  |
| — <i>densus</i> .....               | .. | ..  | .. | 400 |

Table 20 (continued).

| Depth in metres .....                 | 0      | 10     | 20     | 50    |
|---------------------------------------|--------|--------|--------|-------|
| <i>Coscinodiscus concinnus</i> ....   | 200    | 200    | 100    | ..    |
| <i>Melosira sulcata</i> .....         | 200    | ..     | 100    | 900   |
| <i>Navicula distans</i> .....         | ..     | ..     | ..     | 100   |
| <i>Thalassiosira Nordenskjöldi</i> .. | 200    | ..     | ..     | 200   |
| Pennate bottom diatoms ...            | 300    | 100    | 500    | 1,000 |
| Dinoflagellates:                      |        |        |        |       |
| <i>Ceratium longipes</i> .....        | 400    | 100    | ..     | ..    |
| <i>Dinophysis norvegica</i> .....     | 500    | 900    | 100    | ..    |
| <i>Exuviaella baltica</i> .....       | 1,300  | 400    | 100    | ..    |
| <i>Gymnodinium Lohmanni</i> ...       | ..     | ..     | 300    | ..    |
| Gymnodiniaceae .....                  | 200    | 100    | ..     | ..    |
| <i>Massartia rotundata</i> .....      | ..     | ..     | 500    | ..    |
| <i>Peridinium brevipes</i> .....      | 200    | 300    | ..     | ..    |
| — <i>depressum</i> .....              | 100    | 100    | ..     | ..    |
| — <i>minusculum</i> .....             | ..     | 100    | ..     | ..    |
| — <i>triquetrum</i> .....             | ..     | ..     | 100    | 100   |
| — <i>trochoideum</i> .....            | 3,800  | 2,000  | 100    | ..    |
| — sp. ....                            | ..     | ..     | ..     | 100   |
| <i>Phalacroma rotundatum</i> ...      | 100    | ..     | ..     | ..    |
| Other flagellates, etc.:              |        |        |        |       |
| <i>Bodo marina</i> .....              | 300    | 400    | 100    | ..    |
| <i>Carteria</i> sp. ....              | 75,000 | 63,000 | 5,500  | ..    |
| <i>Monosiga marina</i> .....          | 1,000  | 2,500  | ..     | ..    |
| Monades not classified .....          | 62,500 | 50,500 | 17,000 | 7,500 |
| Ciliates:                             |        |        |        |       |
| <i>Laboea strobila</i> .....          | ..     | 400    | 500    | 700   |
| — <i>vestita</i> .....                | 200    | 900    | 3,100  | 600   |
| — sp. ....                            | 100    | 100    | ..     | ..    |
| <i>Lohmanniella oviformis</i> ....    | 200    | 200    | ..     | 200   |
| <i>Mesodinium rubrum</i> .....        | 1,300  | 900    | 600    | 100   |
| <i>Strombidium acutum</i> .....       | ..     | ..     | ..     | 100   |
| <i>Woodania conicoides</i> .....      | ..     | 200    | ..     | 200   |

Table 21.

St. 6607, Sect. Q. Lat.: 56°30' N., Long.: 7°28' E.  
Plankton per litre. 22/5-47.

| Depth in metres .....                             | 0      | 10     | 20     | 28     |
|---------------------------------------------------|--------|--------|--------|--------|
| Temperature, °C.....                              | 9.50   | 5.79   | 2.99   | 3.19   |
| Salinity, per mille.....                          | 33.77  | 33.90  | 34.21  | 34.37  |
| $\sigma_t$ .....                                  | 26.10  | 26.73  | 27.28  | 27.39  |
| P, $\mu$ g-atom/L .....                           | 0.1    | ..     | ..     | 0.15   |
| N <sub>NO<sub>3</sub></sub> , $\mu$ g-atom/L..... | 3.0    | ..     | ..     | 3.0    |
| O <sub>2</sub> , ml/L .....                       | 6.94   | ..     | ..     | 6.67   |
| O <sub>2</sub> , % of saturation .....            | 108.1  | ..     | ..     | 90.3   |
| Number of ml examined.....                        | 2 & 10 | 2 & 10 | 2 & 10 | 2 & 10 |
| Diatoms:                                          |        |        |        |        |
| Asterionella kariana .....                        | ..     | ..     | ..     | 400    |
| Biddulphia aurita .....                           | ..     | ..     | 300    | ..     |
| Chaetoceros borealis .....                        | ..     | ..     | 500    | 300    |
| — densus .....                                    | ..     | ..     | 800    | 200    |
| Coscinodiscus concinnus....                       | ..     | ..     | ..     | 100    |
| Leptocylindrus minimus....                        | ..     | 300    | ..     | ..     |
| Melosira italica.....                             | ..     | ..     | ..     | 400    |
| Navicula distans .....                            | ..     | ..     | ..     | 200    |
| Nitzschia closterium .....                        | 1,500  | ..     | ..     | 500    |
| — delicatissima .....                             | ..     | ..     | 20,800 | 30,500 |
| Pleurosigma angulatum ....                        | ..     | ..     | ..     | 200    |
| Rhizosolenia hebet. f. semisp.                    | ..     | ..     | ..     | 300    |
| Skeletonema costatum .....                        | ..     | ..     | 1,700  | 1,900  |
| Thalassionema nitzschioides.                      | ..     | ..     | 200    | 100    |
| Thalassiosira decipiens .....                     | ..     | ..     | 200    | 1,000  |
| — gravida.....                                    | ..     | 100    | ..     | 100    |
| Pennate bottom diatoms...                         | ..     | ..     | 500    | 1,000  |
| Dinoflagellates:                                  |        |        |        |        |
| Dinophysis crassior.....                          | ..     | 200    | ..     | ..     |

Table 21 (continued).

| Depth in metres .....                          | 0       | 10      | 20     | 30     |
|------------------------------------------------|---------|---------|--------|--------|
| Dinophysis debilior.....                       | ..      | 600     | ..     | ..     |
| Gymnodinium Lohmanni...                        | ..      | 100     | 400    | ..     |
| Gymnodiniaceae.....                            | ..      | 100     | 2,500  | 11,000 |
| Peridinium trochoideum....                     | 1,600   | 1,100   | ..     | ..     |
| Cysts of dinoflagellates....                   | 800     | 600     | ..     | 300    |
| Other flagellates, etc.:                       |         |         |        |        |
| Bodo marina.....                               | ..      | ..      | 500    | ..     |
| Carteria sp.....                               | 18,500  | ..      | 8,500  | 4,000  |
| Monosiga marina.....                           | 1,000   | 500     | 1,500  | 1,500  |
| Phaeocystis sp.....                            | ..      | ..      | +      | +      |
| Pterosperma cristatum.....                     | ..      | ..      | 100    | ..     |
| Monades and flagellates not<br>classified..... | 144,000 | 142,000 | 94,000 | 66,000 |
| Ciliates:                                      |         |         |        |        |
| Dictyocysta elegans.....                       | 200     | ..      | ..     | ..     |
| Laboea conica .....                            | ..      | ..      | 2,100  | ..     |
| — constricta.....                              | ..      | ..      | 100    | ..     |
| — crassula .....                               | ..      | ..      | 600    | ..     |
| — strobila.....                                | ..      | ..      | 700    | ..     |
| — vestita .....                                | ..      | 3,400   | ..     | ..     |
| — sp.....                                      | ..      | 100     | ..     | ..     |
| Lohmanniella oviformis ....                    | 100     | 3,000   | 200    | 500    |
| Mesodinium rubrum .....                        | ..      | 2,200   | 800    | ..     |
| Strombidium acutum .....                       | ..      | ..      | ..     | 100    |
| — sp.....                                      | ..      | ..      | 200    | 100    |
| Tintinnopsis beroidea .....                    | 100     | ..      | ..     | 100    |
| Woodania conicoides.....                       | ..      | 100     | ..     | ..     |
| Ciliates not identified.....                   | ..      | 600     | 400    | 100    |

Plate I.

All figures in Plate I show *Coscinodiscus concinnus* from the surface net sample at Station 6608 (May 29th, 1947). It is a sample of the oil film (see pp. 27—31).

Fig. 1. Valve, high focused. Material treated with sulphuric acid. ( $\times 200$ ).

Fig. 2. Valve, low focused. Material treated with sulphuric acid. ( $\times 200$ ).

Fig. 3. Cell with content of chromatophores and drops of oil. The cell is damaged and the oil is about to seep out. ( $\times 100$ ).

Fig. 4. The surface oil film which was of great extension at the end of May, 1947 (see Fig. 23) as it appeared in the microscope. It is in the main formed of oleaginous *C. concinnus* cells and large or small free drops of oil between the cells. ( $\times 100$ ).

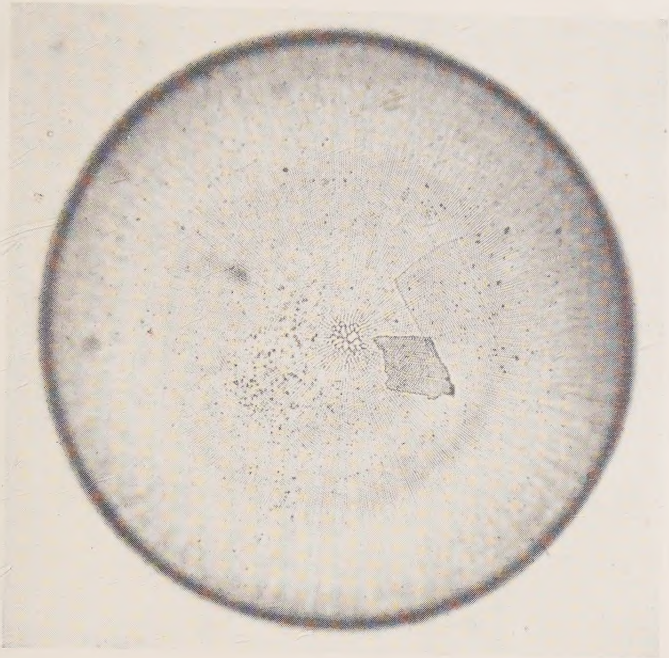


Fig. 1.

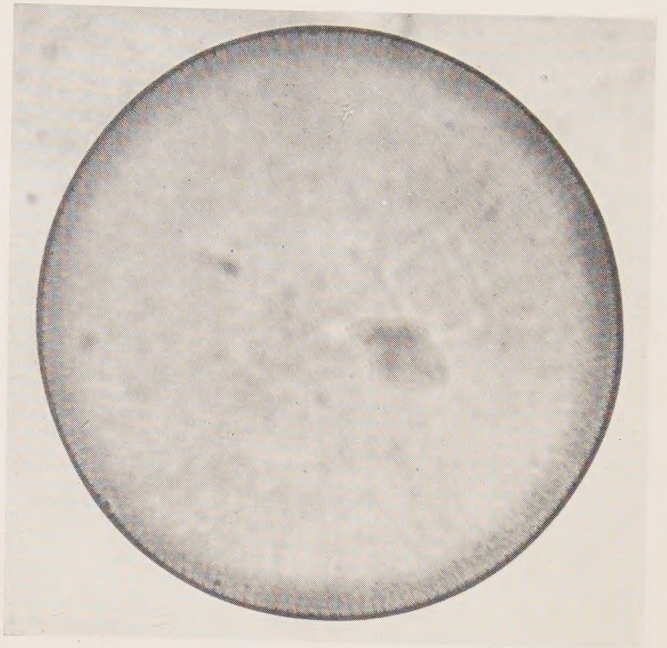


Fig. 2.



Fig. 3.



Fig. 4.



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<sup>1)</sup> The Name »Kommissionen for Havundersøgelser« was from September 1st 1926 changed to: »Kommissionen for Danmarks Fiskeri- og Havundersøgelser«. All Danish fishery research institutions are united to one institution, »Danmarks Fiskeri- og Havundersøgelser«, from April 1st 1952.

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